Leibniz Gemeinschaft

Der Senat

20. März 2018

Stellungnahme zum Leibniz-Institut für Neue Materialien gGmbH, Saarbrücken (INM)

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Vorbemerkung

Die Einrichtungen der Forschung und der wissenschaftlichen Infrastruktur, die sich in der Leibniz-Gemeinschaft zusammengeschlossen haben, werden von Bund und Ländern wegen ihrer überregionalen Bedeutung und eines gesamtstaatlichen wissenschaftspolitischen Interesses gemeinsam gefördert. Turnusmäßig, spätestens alle sieben Jahre, überprüfen Bund und Länder, ob die Voraussetzungen für die gemeinsame Förderung einer Leibniz-Einrichtung noch erfüllt sind.[1]

Die wesentliche Grundlage für die Überprüfung in der Gemeinsamen Wissenschaftskonferenz ist regelmäßig eine unabhängige Evaluierung durch den Senat der Leibniz-Gemeinschaft. Die Stellungnahmen des Senats bereitet der Senatsausschuss Evaluierung vor. Für die Bewertung einer Einrichtung setzt der Ausschuss Bewertungsgruppen mit unabhängigen, fachlich einschlägigen Sachverständigen ein.

Vor diesem Hintergrund besuchte eine Bewertungsgruppe am 27. und 28. Juni 2017 das INM in Saarbrücken. Ihr stand eine vom INM erstellte Evaluierungsunterlage zur Verfügung. Die wesentlichen Aussagen dieser Unterlage sind in der Darstellung (Anlage A dieser Stellungnahme) zusammengefasst. Die Bewertungsgruppe erstellte im Anschluss an den Besuch den Bewertungsbericht (Anlage B). Das INM nahm dazu Stellung (Anlage C). Der Senat der Leibniz-Gemeinschaft verabschiedete am 20. März 2018 auf dieser Grundlage die vorliegende Stellungnahme. Der Senat dankt den Mitgliedern der Bewertungsgruppe und des Senatsausschusses Evaluierung für ihre Arbeit.

1. Beurteilung und Empfehlungen

Der Senat schließt sich den Beurteilungen und Empfehlungen der Bewertungsgruppe an.

Das Leibniz Institut für Neue Materialien (INM) forscht auf dem Gebiet der grundlagen- und anwendungsorientierten Materialwissenschaften. In einem interdisziplinären Ansatz werden aus physikalischer, chemischer und biologischer Perspektive Grenz- und Oberflächenphänomene untersucht. Auf Grundlage der Ergebnisse werden innovative Technologien bis hin zum Pilotmaßstab entwickelt und gemeinsam mit industriellen Partnern in die Anwendung transferiert.

Nach einer kritischen Evaluierung im Jahr 2006 durchlief das INM einen bemerkenswerten Reformprozess. Unter dem seit 2007 am Institut tätigen Wissenschaftlichen Direktor wurden u. a. die traditionellen Arbeiten im Bereich der Nanokomposit-Technologie um zwei neue Forschungsfelder im Bereich der Grenzflächenmaterialien und der Biomaterialien erweitert. Gleichzeitig wurden die grundlagenorientierten interdisziplinären Forschungsarbeiten ausgebaut. Der Leibniz-Senat bescheinigte dem INM bei der letzten Evaluierung 2011 eine über die Erwartungen hinausgehende erfolgreiche Neuausrichtung. Diese positive **Entwicklung** wurde seitdem nahtlos fortgesetzt, so dass das INM mittlerweile zu den international führenden Einrichtungen im Bereich der Materialwissenschaften zählt. Besonders wichtig war es, dass 2015 die seit längerem vakante Position der stellvertretenden Institutsleitung höchst erfolgreich wiederbesetzt wurde.

[1] Ausführungsvereinbarung zum GWK-Abkommen über die gemeinsame Förderung der Mitgliedseinrichtungen der Wissenschaftsgemeinschaft Gottfried Wilhelm Leibniz e. V.

Die **Arbeiten** in den drei Forschungsfeldern des INM sind in insgesamt neun Programmbereiche und zwei Nachwuchsgruppen organisiert. Diese wurden zweimal als „exzellent", dreimal als „sehr gut bis exzellent", dreimal als „sehr gut", zweimal als „gut bis sehr gut" und einmal als „gut" bewertet. Wie bei der letzten Evaluierung empfohlen, konnte das INM die Kooperation zwischen den Gruppen intensivieren. Diese Entwicklung sollte wie geplant weiter vorangetrieben werden, da in der interdisziplinären Zusammenarbeit ein großes Potential für neue wissenschaftliche Erkenntnisse liegt.

Die **Publikationsleistung** wurde seit der letzten Evaluierung noch einmal quantitativ und qualitativ signifikant gesteigert. Auch wurden die Zahl und die Qualität der über **Drittmittel** geförderten wissenschaftlichen Vorhaben bemerkenswert erhöht. Hervorzuheben ist die Einwerbung eines *ERC Advanced Grant* durch den Wissenschaftlichen Direktor. Mit drei Teilprojekten des INM, die ab 2017 im Rahmen eines von der Universität des Saarlandes koordinierten Sonderforschungsbereiches gefördert werden, bestehen zudem gute Voraussetzungen dafür, den positiven Trend bei der Einwerbung von DFG-Mitteln fortzuführen. Das INM wirbt auch in großem Umfang Mittel von Unternehmen ein. Dies ist erfreulich, allerdings muss die vom Aufsichtsgremium beschlossene Zielvorgabe revidiert werden, dass ein Wachstum von Drittmitteln für wissenschaftliche Vorhaben mit einer analogen Steigerung von Industriedrittmitteln einhergeht. Die Zielvorgabe führt zu dem unintendierten Effekt, dass das INM derzeit zum Teil Industrieprojekte bearbeitet, die sich kaum in die Gesamtstrategie einfügen. Der **Technologietransfer** in die industrielle Verwertung ist überzeugend organisiert. Dieser wurde mit dem 2014 gegründeten InnovationCenter INM weiter professionalisiert. Das INM verfügt über eine bemerkenswert hohe Anzahl von Patenten. Es wird zudem begrüßt, dass im Zusammenhang mit einer am Institut entwickelten Technologie derzeit eine Ausgründung geplant ist.

Die Planungen des INM, die Arbeiten ab 2020 auf die Gebiete „Materials in the Digital Environment" und „Biomedical Materials" auszuweiten sind überzeugend und beziehen auch das wissenschaftliche Umfeld am Standort sehr gut mit ein. Zur Finanzierung der dafür notwendigen zusätzlichen apparativen und personellen Ausstattung plant das INM, einen **temporären Sondertatbestand** für die Jahre 2020 bis 2022 anzumelden. Mit zusätzlich insgesamt 7,5 Mio. € (zzgl. Eigenanteil) sollen zwei Nachwuchsgruppen sowie neue Labore eingerichtet werden. Für die Verstetigung der Arbeiten setzt das INM ab 2023 eigene Mittel ein. Die Planungen des INM sind schlüssig und werden nachdrücklich befürwortet.

Für die neuen Laborflächen benötigt das INM **zusätzliche Räumlichkeiten**. Hierfür stellt das Saarland ein derzeit von der Universität genutztes Nachbargebäude mietfrei zur Verfügung. Es wird begrüßt, dass die Universität diese Pläne unterstützt. Damit wird sich auch die sehr eingeschränkte räumliche Ausstattung des INM deutlich verbessern.

Über insgesamt drei seit der letzten Evaluierung gemeinsam durchgeführte Berufungsverfahren wurde die **Kooperation** mit der Universität des Saarlandes ausgebaut. Die Berufungsverfahren wurden zielgerichtet und effizient durchgeführt. Es sollte geprüft werden, ob in Zukunft gemeinsame und paritätisch besetzte Berufungskommissionen eingerichtet werden können, so wie es die „Standards für die Besetzung von wissen-

schaftlichen Leitungspositionen in der Leibniz-Gemeinschaft“ vorsehen. Zusammen mit der Universität und drei weiteren international renommierten Hochschulen wurde zudem ein vom INM koordinierter *Cluster* eingerichtet, in dem regelmäßig gemeinsame Arbeiten auf dem Gebiet der Modellierung und Simulation durchgeführt werden. Damit hat das INM wie bei der letzten Evaluierung angekündigt eine nachhaltige Form gefunden, um die erforderliche Expertise in die Institutsarbeiten einfließen zu lassen. Die parallel dazu laufenden Versuche, einen hochrangigen Experten mit eigener Gruppe einzustellen, führten aufgrund der hohen internationalen Nachfrage noch nicht zum Erfolg, sollten aber weiterverfolgt werden. Innerhalb der Leibniz-Gemeinschaft ist das INM gut vernetzt, so koordiniert es z. B. den Leibniz-Forschungsverbund „Nanosicherheit“.

Das INM hat den Anteil an **Wissenschaftlerinnen** seit der letzten Evaluierung erfolgreich von 29 % auf 42 % erhöht. Zu begrüßen ist insbesondere, dass in den letzten Jahren auf Ebene der Gruppenleitungen zwei Frauen eingestellt wurden, eine von ihnen ist die neue stellvertretende Direktorin. Damit sind derzeit drei der elf Gruppenleitungen mit Frauen besetzt. Das INM sollte diesen Weg fortsetzen und den Frauenanteil auf Ebene der Gruppenleitungen weiter erhöhen.

Dem INM gelingt es im Rahmen eines überzeugenden Gesamtkonzeptes, neue grundlegende Forschungserkenntnisse zu gewinnen und darauf aufbauend innovative Anwendungen zu entwickeln. Das INM erfüllt die Anforderungen, die an eine Einrichtung von überregionaler Bedeutung und gesamtstaatlichem wissenschaftspolitischem Interesse zu stellen sind. Das INM bearbeitet in einem interdisziplinären Ansatz themenbezogene materialwissenschaftliche Forschungsfragen, wie es in dieser Form nicht an einer Hochschule geleistet werden kann. Eine Eingliederung in eine Hochschule wird daher nicht empfohlen.

2. Zur Stellungnahme des INM

Es wird begrüßt, dass das INM beabsichtigt, die Empfehlungen und Hinweise aus dem Bewertungsbericht bei seiner weiteren Arbeit zu berücksichtigen.

3. Förderempfehlung

Der Senat der Leibniz-Gemeinschaft empfiehlt Bund und Ländern, das INM als Einrichtung der Forschung und der wissenschaftlichen Infrastruktur auf der Grundlage der Ausführungsvereinbarung WGL weiter zu fördern.

1 June 2017

Annex A: Status report

INM – Leibniz Institute for New Materials, Saarbrücken

Contents

1. Structure, tasks and institutional environment

Development and funding

The INM – Leibniz Institute for New Materials was founded by the State of Saarland in 1987. Since 1995, the institute has been jointly funded by the federal government and *Länder* governments. The last evaluation by the Senate of the Leibniz Association took place in 2011 (on-site visit in 2010).

Responsible department at Länder level: State Chancellery of Saarland

Responsible department at federal level: Federal Ministry of Education and Research (BMBF)

Mission and tasks

According to the Articles of Association (Gesellschaftsvertrag, 2008), INM's mission is to perform "work in the area of fundamental and application-oriented material research, primarily the research on and the development of new materials." Accordingly, its objectives are "to carry out multidisciplinary cutting-edge research using the latest scientific methods and to cooperate with national and international research institutions, universities and companies." Another objective is to "collaborate with Saarland University and other research organisations in the areas of research, education and teaching".

Legal form and organisation

INM is a non-profit limited-liability company (gGmbH) owned by Saarland University (51%) and the State of Saarland (49%). The bodies of INM are the Shareholders Meeting (*Gesellschafterversammlung*), the Board of Trustees (*Kuratorium*) and the Board of Directors (*Geschäftsführung*). The Scientific Advisory Board advises INM and its bodies on scientific and structural questions (see chapter 6).

The Shareholders' Meeting decides on matters such as the appointment and dismissal of the Board of Directors and the approval of the annual report and of the annual financial statement.

The Board of Trustees oversees the institute's essential commercial, scientific and organisational issues. It consists of twelve members with representatives of the State of Saarland, the German Federal Government and Saarland University, the Chair of the Scientific Advisory Board, a representative of INM's employees and independent individuals from science and industry. Essential areas of responsibility include the approval of the scientific and budget plans (Program Budget), the annual financial statement and the activity report, the appointment procedure for the scientific management personnel, employment contracts and services above or outside the general pay scale, as well as legal transactions and measures that go beyond the scope of the current business.

The Board of Directors consists of two Scientific Directors and one Business Director. One Scientific Director is the Chairman of the board. The Scientific Directors are responsible for establishing the scientific strategy of the institute, and for the planning, execution, and quality control of the scientific work. The Business Director takes responsibility

for commercial, legal, and administrative matters. Directors are appointed for five years, repeated appointment is possible.

Research structure

INMs scientific work is carried out in **nine Program Divisions and two Junior Research Groups**, which are grouped thematically into three Research Fields; these are communication and reporting structures but not hierarchical levels (see appendix 1 and chapter 3).

Furthermore, the ***InnovationCenter INM*** aims at increasing INM's competitiveness in the acquisition of industrial projects by providing professional science-to-business marketing for the scientific groups at INM. It is supported by the Project Support & Technology Transfer group (FF&TT), which handles all formal and legal aspects of collaborative projects. Four **service groups** ("Chemical Analysis", "Physical Analysis", "Engineering Workshop" and "Library") support the scientific work.

National and international scientific environment

INM positions itself among the following national institutions:

- Leibniz Institute of Polymer Research, Dresden (IPF),
- Leibniz Institute for Interactive Materials, Aachen (DWI),
- Leibniz Institute for Solid State and Materials Research, Dresden (IFW),
- Fraunhofer Institute for Silicate Research, Würzburg (ISC),
- Institute of Nanotechnology, Karlsruhe (INT) at the Karlsruhe Institute of Technology (KIT), Helmholtz Association.

INM also monitors the developments at related institutes, such as the more application-oriented Fraunhofer Institutes for Mechanics of Materials (IWM) in Freiburg and for Manufacturing Technology and Advanced Materials (IFAM) in Bremen. In the Max Planck Society, subdivisions of the Max Planck Institute for Colloids and Interfaces in Golm and the Max Planck Institute for Polymer Research in Mainz perform fundamental work of interest to INM.

Several institutions at university centers cover topics comparable to INM such as the Cluster of Excellence on Engineering of Advanced Materials at the University of Erlangen, the Natural and Medical Sciences Institute (NMI) at the University of Tübingen and the focus on materials science at the TU Dresden.

On the international level, the materials departments of the following institutions share common interests with INM: Adolph Merkle Institute in Fribourg, CH, Luxembourg Institute of Science and Technology (LIST) in Luxembourg, VTT Technical Research Centre of Finland, the ETH Zurich, Switzerland, the Wyss Institute in Cambridge, USA, the Korea Institute of Science and Technology (KIST) in Daejon, South Korea.

Universities with significant topical overlap include the University of California at Santa Barbara, USA, the Northwestern University in Evanston, USA, and the Future Industries Institute in Adelaide, Australia.

National interest and justification for funding as a non-university institution

According to INM, the development of new materials with application-relevant property spectra has become a highly competitive field worldwide and requires the collaboration of several disciplines. INM states that its activities imply an interdisciplinary research environment with collaborations and benchmarking on a worldwide scale. INM fosters scientific partnerships with numerous universities and research facilities on all continents. Application-oriented development is carried out with technology partners all over the world. Particularly important industrial collaborators are located in Japan, Korea and Brazil.

INM elaborates that its research and development has to take place in an independent non-university research institution. Its multi-disciplinarity requires the seamless knowledge transfer and cooperation between different scientific fields, without the organisational boundaries between departments and faculties at universities. The flat organisational structure ensures sharing of ideas, expertise and equipment among the groups and enables the board of directors to efficiently coordinate or reposition the research profile.

According to INM, its large-scale equipment requires spatial and personnel infrastructure that can best be provided in a non-university environment. Because of the time lag, typically 10 to 15 years, between invention and industrial application, long-term strategic funding is indispensable for the successful commercial exploitation of INM's new materials and technologies.

INM states that its institutional independence as a non-profit company (gGmbH) allows for considerable flexibility related to the proprietary nature of industrial cooperation and to bookkeeping and financial management. Technical and administrative regulations specific to technology transfer would be difficult to enforce at a university (research and development contracts, non-disclosure agreements, patent policy, innovation controlling).

2. General concept and profile

INM performs multi-disciplinary research on interface and surface phenomena and their exploitation in the design of new functional coatings, materials and structures. The research integrates materials synthesis, physical analysis, process development and biological functionalisation. The institute aims for leadership in the **four key topics** of (i) contact engineering, (ii) electroactive interfaces, (iii) 4D materials and nanocomposites, and (iv) cell-materials interaction. INM also aims at transferring its scientific results into application-oriented concepts and products.

According to INM, its research has the following **characteristics**:

- The integration of chemical synthesis, physical properties, and development of advanced methods: INM considers its thematic diversity as an important driver for new ideas and cross-innovations in order to develop key enabling technologies for appli-

cations. Coherence is achieved by INMs focus on interface phenomena and the above mentioned four key topics.

- Synergy between fundamental and application-driven research: INM conducts curiosity-driven research in connection with academic partners and develops novel materials in proprietary collaborations with industry.
- Flat organisational structure: INM builds on a flat organisational model without intermediate hierarchies between the research groups and the directors. In view of INM this is instrumental for enhancing bottom-up creativity, decision making, communication, and the visibility of group leaders.
- Strong links with Saarland University: Seven group leaders hold joint professorships in the Departments of Materials Science and Engineering, Chemistry, and Physics. In addition three INM Fellows (see chapter 4) are based at the university.

Development of the institution since the last evaluation

Since the last evaluation in 2011 several group leaders accepted offers of positions in industry and academia. After evaluation of the institute's research portfolio, the directors decided to close their three Program Divisions ("Nanoprotect" in 2011, "CVD/Biosurfaces" in 2015 and "Biomineralization" in 2016) and two Junior Research Groups ("Metallic Microstructures" in 2013 and "Switchable Surfaces" in 2015) and to redistribute the resources to new groups.

Since the last evaluation, INM established the following **five new Program Divisions** (for details see chapter 3):

- Dynamic Biomaterials: INM states that the most significant development was the appointment of the new second Scientific Director in 2015. She expands the materials chemistry expertise at INM and establishes the Research Field "Biointerfaces".
- Innovative Electron Microscopy: The institute appointed the Program Division head in 2012. His research focuses on liquid-phase electron microscopy for materials and biomedical applications, and also includes innovations in correlative and three-dimensional (3D) microscopy.
- Energy Materials: In 2012 the institute hired a junior group leader for Energy Materials. His research is devoted to the development of functional electrode materials for energy storage and water purification. In 2015, this group was promoted to a Program Division.
- Structure Formation: To strengthen research on fundamental processes in functional nanocomposites, the former Junior Research Group Structure Formation was converted into a Program Division in 2014. Through this, the group leader, who had received an offer from a German university, could be retained.
- InnovationCenter INM: The bridge from science to application was strengthened by the creation of the InnovationCenter INM in 2014.

Moreover, **two new Junior Research Groups** were established:

- Switchable Microfluidics: The group was established in 2015. The group develops responsive polymer materials and devices for handling fluids in microreactors.
- Cytoskeletal Fibers: To strengthen the Research Field "Biointerfaces", the group was created in January 2017 under leadership of a Junior-Professor of Saarland University.

Further important developments since the last evaluation are the following:

- Creation of a *Modelling and Simulation Cluster* coordinated by INM: Modelling and numerical simulation is essential for many materials development projects. These activities are largely covered by external cooperation. In 2016, an external Cluster was established for targeted collaboration with modelling experts (e. g. at Saarland University, Cambridge University, and UC Santa Barbara).
- Introduction of Focus Projects in 2013: To foster cooperation between the different groups INM initiated internal Focus Projects providing them with temporary funding amounting to about one scientist-year for work carried out jointly across multiple Program Divisions. Up to now, funding has been provided for 16 projects for a total amount of approx. 1.23 M€. About 15.4 % (2016) of INMs publications are co-authored by members of different groups and several third party funding grants were acquired in cooperation.
- Introduction of *INM Fellows* in 2013: This instrument is designed to strengthen cooperation with the university environment. Scientists from universities receive funding for a joint research project with INM researchers. Since 2013, three fellows have been appointed at Saarland University (one still active). One fellow (still active) has been appointed at the Monash University in Melbourne, Australia.
- The Leibniz Research Alliance for Nanosafety initiated in 2012 and coordinated by INM: This alliance pools the competences of several Leibniz Institutions to cooperate towards providing safe nanomaterials. The Program Division "Nano Cell Interactions" is instrumental for this Alliance.

Results

Publications

Between 2014 and 2016, INM produced 300 Articles in peer-reviewed journals, 99 individual contributions to edited volumes and 31 other publications (see appendix 2). Since the last evaluation, the number of publications in peer-reviewed journals per year has increased from 68 in 2010 to 110 in 2016. According to the institute, at the same time the average Journal Impact Factor has increased from 2.6 to 5.3. INM aims at generating one peer-reviewed publication per year for each full-time equivalent (FTE) scientist (including doctoral candidates). In 2016, INM produced 1.2 (1.5) peer-reviewed publications per FTE scientist including (excluding) doctoral candidates. INM follows the Open Access strategy of the Leibniz Association and favours Open Access publication whenever scientifically advisable.

Technology transfer and patent strategy

Since the last evaluation, according to INM, the activities in materials development and technology transfer have grown. Examples of topics for recent development projects are materials and coatings for new touch screen concepts, switchable adhesive surface patterns for robotics, sustainable anti-corrosion and anti-wear coatings, analytical methods for high-performance alloys, and cosmetic products. In collaboration with an external commercialisation partner, market studies are performed to identify industrial demands for innovative products. Initial plans for a start-up company in one of INM's more mature technologies are currently underway.

Between 2014 and 2016, INM filed for 17 patent families and 13 patent families (corresponding to 40 individual patents) were granted (see appendix 2). Before filing for a patent, intellectual property generated in the institute undergoes an established evaluation process, followed by approval of the directors and the heads of the InnovationCenter INM. The institute's patent portfolio is regularly inspected and less promising patents are abandoned, which happened for 23 patent families between 2014 and 2016. Currently, INM holds 73 patent families corresponding to 456 individual patents.

Academic events

INM organises or co-organises about 30 scientific events annually on different topics. Some noteworthy examples are the *Conference on In Situ and Correlative Electron Microscopy* (CISCEM 2014 and 2016, Saarbrücken), the *Conference on Capacitive Deionization & Electrosorption* (CDI&E 2015, Saarbrücken), the *International Symposium on Nanosafety* (2013 and 2017, Saarbrücken), the *Symposium Transparent Conductive Materials: From Fundamental Understanding to Applications* (E-MRS Fall Meeting 2015, Warsaw), and the ERC Workshop *Engineering of Bio-Inspired Materials* (2016, Saarbrücken).

INM presented itself in national and international trade fairs and exhibitions such as Hannover Messe (Hanover Fair), Nano Tech in Tokyo, Techconnect World in Washington, Motek (InternationaleFachmesse für Produktions- und Montageautomatisierung) in Stuttgart, and IAA (Internationale Automobil-Ausstellung) in Frankfurt.

Public relations

INM communicates its research to the general public, informs the local community about innovations from their region, and notifies decision makers from industry of current technological developments. As communication formats, digital and print media as well as press work are utilised. INM's internet presence was recently revised and updated. INM issues 40 to 50 press releases each year, two thirds of which are in German and the rest in English. Topics include research results, projects and collaborations, major events, trade fairs, and details on personnel and awards. News about INM appeared, for example, in the Saarbrücker Zeitung, the Frankfurter Allgemeine Zeitung, Süddeutsche Zeitung, VDI-Nachrichten, and Focus.

Strategic work planning for the next few years

For the next years, INM's scientific work will be focused on the four key topics mentioned above and will be guided by the following **priorities**:

- Sharpening of INM's profile: According to the institute, one of the distinct feature will remain the multitude of disciplinary angles to tackle scientific problems and technological solutions. To realise successful developments INM addresses areas, where it can synergistically contribute more than the sum of its individual groups. Particularly promising areas are the four key topics mentioned above.
- Integration of materials innovation and biomedical research: INM wants to position itself at the intersection of materials innovation and biomedical function. Considerable synergy shall result from combining INMs experience in materials science and technology with new competence in cell biology and bioengineering with the aim of a thematic integration of these activities.
- Connecting molecular, nanoscale, and macroscopic length scales: INM has a history in chemical nanotechnology and its application for the creation of new materials. As a next step, INM plans to integrate molecular length scales and system-level requirements in a multi-scale strategy that is required for new material challenges.

Furthermore, the following two research areas are already pursued on a small scale at INM, but are in view of INM promising **new areas of future growth**. They also take advantage of the setting on the campus of Saarland University:

- Materials in the Digital Environment: A central challenge of the digital environment is the interaction between digital devices and human users. The Saarland Informatics Campus includes a strong computer science department, two Max Planck Institutes, and the German Research Institute for Artificial Intelligence. Over recent years, INM has developed complementary activities, e. g. in electric charge transport, storage, and harvesting. This allows to address challenges of new functional materials in a digital environment like (i) new flexible materials and structures for wearable interfaces, (ii) mechanics and physiology of haptics and (iii) mobile energy harvesting.
- Biomedical Materials: INM links materials development to medical research in cooperation with the Faculty of Medicine at Saarland University. Two strategic areas for future growth are identified. (i) Personalised printed tissues for advanced drug testing, e. g. specialized bioinks that reflect tissue- and patient specific characteristics. This research line will connect INM to the Pharmacy Department at the University and the Helmholtz Centre for Infection Research. (ii) Immunomodulatory materials for instructive implants able to regulate the body's innate regeneration ability. This topic expands existing cooperation in the field of immunology with Biophysics Department within the SFB 1027 and in the field of regenerative medicine with Experimental Surgery at the Faculty of Medicine.

Application for a temporary extraordinary item of expenditure

In order to pursue the two new scientific areas, INM sees a need for additional laboratory capacities. According to INM this has two reasons:

1. New research directions and broader interdisciplinary mission: Compared to ten years ago, the institute has now a more interdisciplinary character and INM accommodates a broader spectrum of scientific methods and technologies ranging from chemical synthesis and physical deposition methods to in-situ characterisation techniques and processing. The quantitative and qualitative requirements for specialised laboratory space have hence increased and will get even more impact with the planned two new research areas.
2. Increased external funding: The level of external funding has more than doubled in the last five years. Further growth is anticipated from the current level of grant applications and industrial contracts. Specialised new projects frequently require new hires, but also space for additional large-scale equipment. Even in the present situation, INM sees itself constrained to accommodate further large-scale grants.

According to INM, the planned expansion of work requires approx. 1000 m^2 additional capacities: for laboratories with chemical synthesis specifications (400 m^2), for laboratories with cell biology specifications with an S2 safety level (200m^2), and for laboratories for physical measurements (400 m^2). For this, INM envisages the gradual takeover of an adjacent wing of one of INMs buildings which is used today by Saarland University. Preliminary consultation with the university has confirmed that such a solution is feasible. INM's Board of Trustees already approved such a possible development. The state of Saarland, owner of the buildings, will leave the premises to INM at no charge.

In order to build and equip the planned new laboratories, INM plans to apply for a temporary increase in its institutional funding (temporary extraordinary item of expenditure/*Sondertatbestand*). Altogether, INM estimates the additional costs to be about 2.5 M€ per year for the years 2020 to 2022. The long-term funding will be secured via internal redistribution and additional third party funding. This investment is needed for

- large scale facilities (high-resolution microscopy and analytical techniques),
- laboratory infrastructure with instrumentation and equipment,
- office equipment,
- and additional personnel costs (two groups, each consisting of two scientists, two doctoral students and one technician).

From its own budget INM finances approx. 0.5 M€ each year, so that the additional institutional funding needed by INM for the period 2020 till 2022 would be approx. 2 M€ per year.

Appropriateness of facilities, equipment and staffing

Funding

In 2016, INM's institutional funding was approx. 17.6 M€ (see appendix 3).

Additionally, some 5.1 M€ were obtained from revenues from project grants (corresponding to 22 % of the overall budget). The revenues split into 1.4 M€ from industry, 1.4 M€ from federal and *Länder* governments, 1 M€ from the EU, 0.7 M€ from the competitive procedure of the Leibniz-Association, and 0.4 M€ from the DFG. Furthermore, in

2016 INM obtained 0.5 M€ (2 %) from revenues from industrial property rights. The total external funding thus amounts to 32 % of the institutional funding.

Amongst the contributing projects INM highlights the following:

- *Junior Investigator Grant 3D Nanostructured Electrical Energy Storage Systems*, German Federal Ministry of Education and Research (BMBF), 3.6 M€, 2012-2017.
- *Competition NanoMatFutur Nanostructured Coatings for Photovoltaics and Electronics from Controlled Particle Deposition* (BMBF), 2.3 M€, 2013-2017.
- ERC Advanced Grant, *Engineering of biomimetic surfaces: Switchable micropatterns for controlled adhesion and touch* (EU), 2.5 M€, 2014-2019.
- *Gecomer® Technology Transfer to Industrial Application* (Leibniz Association), 1.26 M€, 2016-2019.
- *Leibniz Research Cluster Organic/synthetic multifunctional meso-production units* (BMBF initiative Biotechnology 2020+), 0.95 M€, 2015-2020.
- *InnovationsWerkstatt Leibniz – Entwicklung der Innovationsfähigkeit von Forschungsinstitutionen im Querschnittsbereich durch Einbindung von KMU* (Development of the innovation capability of research organizations involving small and medium enterprises) – Science4KMU (BMBF), 0.73 M€, 2016-2019.
- Not included in the numbers for 2016 are three individual projects within the Collaborative Research Center (SFB 1027) *Physical modeling of non-equilibrium processes in biological systems* (DFG), 0.884 M€, 2017-2020.

Equipment and IT

With the combination of basic funding and several large-scale externally funded projects, INM has been able to continuously update and upgrade its equipment to keep pace with new methodical developments. Large-scale equipment procured since the last evaluation include a Scanning Transmission Electron Microscope (3.28 M€), a dual ion-beam instrument (1 M€), a two-photon confocal microscope (0.7 M€), small-angle X-ray scattering equipment (0.6 M€), a laser lithography system (0.5 M€), an OpAL Plasma + Thermal ALD (0.4 M€), and an environmental scanning electron microscope (0.4 M€).

INM's IT service provides secure use of information technologies and services. The level of expertise is regularly updated in collaboration with Saarland University and in dialog with the IT working group of the Leibniz Association.

Space situation

INM occupies buildings belonging to the State of Saarland on the campus of Saarland University. The infrastructure available comprises about 2,000 m^2 of office space and 5,200 m^2 of laboratory and workshop space. In recent years, the laboratories, technical facilities, and building services were modernised. Thanks to a special investment item amounting to 1.8 M€ connected to the appointment of the Scientific Director in 2015, five 60 m^2 laboratories were renovated and equipped for the Research Field “Biointerfaces”.

Personnel

Since the last evaluation, the number of employees has increased substantially in accordance with the rise in external funding. Since 2009, the number of employees has risen from 185 to 241 (December 31, 2016, see chapter 4 and appendix 5). According to INM, the institute has exceeded the limit of its available office space and laboratory capacities (see above).

3. Subdivisions of INM

3.1 Research Field "Interface Materials"

This Research Field consists of four Program Divisions. The work focuses on physical and physico-chemical processes at interfaces. Its research includes the design and synthesis of materials and structures with high densities of surfaces and interfaces, their characterisation by advanced in-situ microscopy techniques, and the modeling and prediction of properties. Recent developments include a progressive shift from scientific concepts to practical applications (e. g. in adhesives and energy storage).

3.1.1 Program Division "Energy Materials"

(5 FTE research and scientific services, 4.15 FTE doctoral students, 1 FTE technical lab staff)

The Program Division emerged in December 2015 from a Junior Research Group, installed in 2012 and catalysed by a Junior Investigator Grant of the German Federal Ministry of Education and Research. The head of the group was appointed full professor (W3) at Saarland University in December 2015. The group synthesises carbon and hybrid materials ranging from few-nanometer carbon onions to mm-sized monoliths, and uses them as functional electrode materials. It employs various material characterisation techniques and combines these with in-situ methods to track structural changes during charging and discharging. Application targets are materials for energy storage, recovery and harvesting, and electro-chemical water treatment.

In the future, the group plans to expand work on aqueous and organic redox electrolyte systems. These efforts are promoted by the extended use of in-situ techniques and simulation tools to monitor and model ion migration inside nanoporous systems and volumetric changes of electrode materials.

Between 2014 and 2016, the group published 61 articles in peer-reviewed journals, six individual contributions to edited volumes, and two other publications. In the same period, the revenues from project grants totalled 1.6 M€ and were obtained almost entirely from the Federal and *Länder* governments. Additionally, the program division filed one patent.

3.1.2 Program Division "Functional Microstructures"

(8.5 FTE research and scientific services, 2.6 FTE doctoral students, 6.1 FTE technical lab staff)

The Program Division carries out research on surface microstructures that derive new functionalities from bioinspired micropatterns. The focus lies on the development and design of artificial patterns that mimic mechanical, especially adhesive, functions, which are of industrial interest. This research on "fibrillar surfaces" was originally initiated by collaboration with biologists who studied attachment mechanisms of insects and geckos. The group identified the "principle of contact splitting" in fibrillar designs, where intimate contact is achieved with negligible elastic strain penalty, and was among the first to demonstrate artificial attachment devices based on this effect.

In the future, micropatterned surfaces will play a central role in the group's work. Among the fundamental aspects to be explored are the kinetics and statistics of detachment events of fibrillar arrays and new functions such as electrical interfacing and haptics. Modeling and simulation will be extended to include non-linear effects.

Between 2014 and 2016, the group published 36 articles in peer-reviewed journals, two individual contributions to edited volumes, and four other publications. In addition, four patents were filed. In the same period the revenues from project grants totalled 1.9 M€. 1.2 M€ were obtained from the European Union (European Research Council), 0.3 M€ within the competitive procedure of the Leibniz-Association and 0.2 M€ from industry. Furthermore, three doctoral degrees were obtained.

3.1.3 Program Division "Nanotribology"

(5 FTE research and scientific services, 1.18 FTE doctoral students)

The Program Division explores and applies molecular mechanisms of friction and adhesion. The goal is to study the mechanical properties of surface materials across length scales and to engineer sliding contacts for active control of friction and wear. Methods include high-resolution friction force microscopy. The work aims at innovative experimental approaches and applications to new materials such as graphene and ionic liquid lubricants or supramolecular assemblies. Recent studies include the investigation of friction mechanisms at different length scales, which has revealed a synergistic effect of particular fillers in polyimide-based composites.

In the coming years, the group plans to evolve the molecular engineering of contacts for an active control of friction and adhesion. Key topics will include active control of friction by responsive molecular layers, electroactive interfaces for the control of lubrication, and tribo-electrification.

Between 2014 and 2016, the group published 19 articles in peer-reviewed journals, five individual contributions to edited volumes, and one other publication. In the same period, the revenues from project grants totalled 0.7 M€ and were obtained almost entirely from the DFG. Furthermore, two doctoral degrees were obtained.

3.1.4 Program Division "Electron Microscopy"

(4 FTE research and scientific services, 0.5 FTE doctoral students, 1 FTE technical lab staff)

The Program Division was founded in 2012 with the appointment of its head. The group conducts interdisciplinary research at the interface of physics of electron microscopy, biophysics, materials science, and image processing. The focus lies in the area of in-situ and liquid-phase scanning transmission electron microscopy (STEM). The group develops methods for the study of functional materials at realistic conditions. This also includes exploration of new routes for correlative light- and electron microscopy, and three-dimensional (3D) data acquisition using intelligent STEM- and image reconstruction strategies. A key achievement since the last evaluation was the improved understanding of electron beam interactions with nanoparticles in aqueous solution during *in-situ* electron microscopy.

For the future, the group plans to further grow in the research area of in-situ electron microscopy, in particular, in liquid-phase electron microscopy. Plans include the development of novel liquid cells using graphene membranes for top resolution imaging of processes at the solid/liquid interface as well as the advancement of the time resolution using high-speed STEM with intelligent data acquisition strategies.

Between 2014 and 2016, the group published 53 articles in peer-reviewed journals, 39 individual contributions to edited volumes, and three other publications. In addition, three patents were submitted. In the same period, the revenues from project grants totalled 0.7 M€ and were obtained almost entirely within the competitive procedure of the Leibniz-Association.

3.2 Research Field "Nanocomposite Technology"

This Research Field consists of three Program Divisions. Functional composites are designed with particles that tune optical, mechanical, electronic, protective, and barrier properties. It develops new, active composites that react to the external stimuli or damage – i. e. to scratches or to the onset of corrosion – or can change their properties when required. In cooperation with industrial users, the Research Field evaluates, adapts, and transfers new composites to the markets.

3.2.1 Program Division "Nanomers"

(7.23 FTE research and scientific services, 0.5 FTE doctoral students, 3.86 FTE technical lab staff)

The Program Division develops nanocomposite-based multifunctional protective coatings and compact materials. Materials synthesis is accompanied by the adaptation to processing techniques such as wet coating, powder coating or electrodeposition. The group integrates proofs-of-concept, upscaling and environmental issues in its work and aims at a transfer to industry. The main application fields are heavy metal-free active corrosion protection, hygienic coatings and tribological and antifouling surfaces for heavy duty applications. The program division filed patents related to efficient multifunctional barrier coatings for steel protection and for tribological coatings with inte-

grated corrosion protection. In addition, the group patented the synthesis and use of novel flake-type zinc phosphate particles showing a re-passivation effect on steel after coating damage. The synthesis and the use of nanostructured metal colloids were protected in two patent applications

In the future, polymer composites will remain the material base to tailor multifunctional interfaces. Potential industrial transfer is seen in the fields of anisotropic particle synthesis and active corrosion protection to paint and automotive supplier industries.

Between 2014 and 2016, the group published one article in peer-reviewed journals, eight individual contributions to edited volumes, and one other publication. In addition, five patents were submitted. In the same period, the revenues from project grants totalled 0.8 M€ and were obtained almost entirely from industry. Furthermore, one doctoral degree was obtained.

3.2.2 Program Division "Optical Materials"

(10.89 FTE research and scientific services, 2.6 FTE doctoral students, 7 FTE technical lab staff)

The Program Division focuses on material synthesis for passive and active optical coatings, and the production of optical and electro-optical functional nanocomposite coatings that influence the propagation of the light. The group conducts research with a strong application orientation and a view to the utilisation in products. Basic research is carried out to build new and to optimise existing technology platforms. The head of the group is also head of the InnovationCenter INM (see below). Results include the development of a process for scratch resistant layers on glass on the basis of the deposition of thin aluminum layers on glass, followed by a tempering step under oxidising atmosphere.

In the next years, the group will place a major focus on designing materials with addressable optical properties. This comprises homogeneous composite materials containing nanoparticles or specific molecules as well as meta-materials including photonic crystals and plasmonic nanostructures. Progress in new materials will be complemented by adapted innovative coating and printing techniques.

Between 2014 and 2016, the group published 18 articles in peer-reviewed journals, seven individual contributions to edited volumes, and three other publications. In addition, the group has filed 5 patents and 8 patents were issued. The revenues from project grants totalled 2.1 M€. 1.1 M€ were obtained from industry, 0.6 M€ from the EU, and 0.4 M€ from the Federal and *Länder* governments. Furthermore, one doctoral degree was obtained.

3.2.3 Program Division "Structure Formation"

(4 FTE research and scientific services, 3.4 FTE doctoral students, 3 FTE technical lab staff)

The group established in 2008 as a Junior Research Group became a Program Division in 2014. The head of the group is also deputy head of the InnovationCenter INM (see below) and was appointed full professor (W3) at Saarland University in 2016. The group

investigates how dispersed particles, molecules, and polymers assemble to form defined structures. The group exploits spontaneous structure formation processes to create "rationally structured composites" with new and improved functionality. The structured nanocomposites are used as sinter-free inks and for transparent conductive electrodes.

In the future, the concept of structured nanocomposites will be expanded to soft electronic materials, thermal management, and structured composites that combine mechanical, electrical, and optical properties in new ways.

Between 2014 and 2016, the group published 33 articles in peer-reviewed journals, four individual contributions to edited volumes, and four other publications. In the same period the revenues from project grants totalled 2.5 M€. 2.1 M€ were obtained from the Federal and *Länder* governments and 0.3 M€ from the DFG. Furthermore, two doctoral degrees were obtained.

3.3 Research Field "Biointerfaces"

This Research Field consists of two Program Divisions and two Junior Research Groups. Polymer materials and cellular microenvironments are developed that mimic the dynamic biochemical and biophysical properties of natural tissues, and are applied to recreate cellular scenarios of biomedical relevance. The field hosts a synergistic combination of soft matter synthesis and processing, high resolution microscopy and cell biology competences. The Research Field is under intense development and cooperates with clinical partners for future translation of results into biomedical solutions.

3.3.1 Program Division "Dynamic Biomaterials"

(12 FTE research and scientific services, 4.14 FTE doctoral students, 0.7 FTE technical lab staff, 1 FTE Post-doctoral scholarship recipient)

The Program Division was founded in September 2015 with the appointment of the new Scientific Director and head of the Program Division. The group members started their work in new laboratories at INM in March 2016. The Program Division plays a central role for the profile definition of the Research Field "Biointerfaces". The group studies the use of light to modulate biomaterials properties and to provide specific signals to embedded cells on demand and with spatiotemporal resolution. A central topic is the optoregulation of integrin-mediated communication between cells and materials.

In the next years, the development of optoregulated cellular microenvironments will remain a major topic in the group. It is planned to expand the synthetic competences to biochemical methods and exploit optogenetic tools to regulate material properties and cell-materials interactions.

In 2016 the group published seven articles in peer-reviewed journals and three individual contributions to edited volumes. The revenues from project grants totalled 0.3 M€, of which 0.1 were obtained from the DFG.

3.3.2 Junior Research Group "Switchable Microfluids"

(2 FTE research and scientific services, 0.86 FTE doctoral students, 1 FTE technical lab staff, 1 FTE Post-doctoral scholarship recipient)

The Junior Research Group was established in September 2015 to carry out the BMBF funded project "Switchable mesostructured surfaces to the compartmentalisation of cell biological key reactions". This project is part of the Leibniz Research Cluster (LRC) "Bio/synthetic multifunctional meso-production units" that integrates different Junior Research Groups at five Leibniz Institutes and is part of the BMBF initiative Biotechnology 2020+. Within this collaborative framework, the group develops reaction platforms for manipulating multi-step cell-free biosynthesis in sub-microliter volumes. First results include the design of new chemistries and fabrication approaches to externally control the liquid segregation within polymeric networks in time and space.

The future strategy is to combine responsive materials and nanotechnology for the development of large-scale compatible processes to obtain switchable mesostructured surfaces. In collaboration with the other LRC groups, the aim is to demonstrate the potential of the developed reactor platforms in cell-free biosynthesis.

In 2016 the group published four articles in peer-reviewed journals and one other publication. In 2015 and 2016 the revenues from project grants totalled 0.3 M€ and were obtained entirely from federal funds within the BMBF competition Biotechnology 2020+ (Leibniz Research Cluster).

3.3.3 Junior Research Group "Cytoskeletal Fibers"

The head of the Junior Research Group is W1 Junior Professor of Biological Physics at Saarland University since 2013 and joined INM in January 2017. She holds a temporary joint appointment (until 2020). With the new competences, INM wants to complement the chemistry-oriented groups in the Research Field "Biointerfaces" and reinforce the biological and biophysical expertise at INM. The group investigates the unique properties and the role of cytoskeletal components (actin fibers and intermediate filaments) when cells contact particular interfaces, or when they are placed in specific environments. The group recreates and biologically validates such natural cellular behavior at engineered interfaces and microenvironments.

In the future, collaborations within the other groups within the Research Field are planned. The role of adhesiveness changes for cell migration will be studied in cooperation with the group "Dynamic Biomaterials". Reproduction of further active components of the cellular environments is envisioned in collaboration with the group "Switchable Microfluidics".

3.3.4 Program Division "Nano Cell Interactions"

(3 FTE research and scientific services, 1 FTE doctoral students, 2 FTE technical lab staff)

The group has been established in 2008 as a Junior Research Group and became a Program Division in 2010. It investigates the interactions between nanoparticles and cells or tissues in light of the possible effects of these materials on human health. A major task is

the coordination of the Leibniz Research Alliance for Nanosafety (see chapter 4). This alliance of six Leibniz Institutes was established in 2012 and aims to gain an in-depth understanding of nanoparticle-induced effects, to develop safe nanomaterials, to generate a digital data infrastructure for nanosafety, and to analyse public perception of the field. The group has an interlinking role within the alliance due to its expertise in analysis of nanoparticle effects at the cellular level together with the wide experience in materials development at INM.

The future work of the group will address four main topics, which are also focal areas of the Leibniz Research Alliance for Nanosafety: Interaction mechanisms, prediction of hazard potential, safe material developments and intracellular delivery. The medium term objective is to translate the results to the development of safe nanomaterials.

Between 2014 and 2016 the group published 13 articles in peer-reviewed journals, and one individual contribution to edited volumes. In the same period the revenues from project grants totalled 0.3 M€. 0.1 M€ were obtained from the Federal and *Länder* governments and 0.1 M€ from foundations. Additionally, the program division filed two patents.

3.4 Cross Linking Area "InnovationCenter INM"

(5.5 FTE research and scientific services, 0.5 FTE doctoral students, 3 FTE technical lab staff)

The *InnovationCenter INM* (*InnovationsZentrum INM*) was founded in 2014. It provides a platform that supports the transfer of the scientific and technological developments at INM into practicable solutions for industrial and technological applications. The group cooperates with INMs research groups and industrial partners. By providing science-to-business marketing competence, its aim is to enhance INM's competitiveness in the acquisition of industrial projects. It assists INM researchers in contract acquisition, engineering, and up-scaling to pilot plant scale. The group also supports external partners and provides companies with access to the methodical expertise and analytical equipment of the institute. In recent years, the main emphasis of the technology transfer activities was on the scaling of printable transparent conductive materials, the demonstration and up-scaling of bioinspired adhesives concepts, and self-healing protective coatings. According to INM, since the foundation of the *InnovationCenter INM* the direct industrial income increased by almost 50 % and nearly half of the industrial volume is now generated outside of Europe.

Between 2014 and 2016, the group published eight articles in peer-reviewed journals, two individual contributions to edited volumes, and five other publications. In the same period, the revenues from project grants totalled 1.4 M€. 1 M€ were obtained from industry and 0.2 M€ within the competitive procedure of the Leibniz-Association.

3.5 Service Groups

There are four Service Groups at INM (see below). Scientific results are generated in collaboration with the research groups of INM.

3.5.1 "Chemical Analysis"

The Service Group "Chemical Analytics" runs facilities for the separation and analysis of volatile and soluble organic compounds, for chemical element analysis and for preparation of inorganic and organic sample mixtures. The group offers support in the development of analytical methods for complicated sample mixtures.

3.5.2 "Physical Analysis"

The Service Group "Physical Analytics" was re-established in 2015 in order to provide electron-microscopic and X-ray characterisation methods. The group is equipped with various techniques and has expertise in the preparation and analysis of aqueous nanoparticle solutions, hydrogels and biological samples, covering the whole materials spectrum of the institute.

3.5.3 "Engineering Workshop"

The task of the Service Group "Engineering Workshop" is to develop and manufacture systems and components for basic and applied research in the Program Divisions. The activities range from small laboratory devices to pilot plants.

3.5.4 "Library"

In November 2016, as part of a cooperation agreement between Saarland University and INM, the former INM Library and the Science and Technology Library of Saarland University agreed to form a new joint library funded by Saarland University and INM. Its main task is to acquire, develop and make available print and electronic media for students and scientists of both institutions.

3.5.5 Other items not bound to program divisions and service groups

In 2014-2016, the revenues from project grants acquired by the Project Support & Technology transfer group and Service Groups totalled 0.5 M€. 0.3 M€ were obtained by Federal and *Länder* governments and 0.2 M€ from industry. Furthermore, INM obtained a total of 1.3 M€ in revenues from intellectual property rights.

4. Collaboration and networking

Collaboration with Saarland University

Since the last evaluation in 2011, the institute has increased the number of professorial appointments with Saarland University. The following two persons were already professors at Saarland University at the last evaluation:

- The Scientific Director and head of the Program Division “Functional Microstructures” was jointly appointed W3 Full Professor for New Materials in the Department of Materials Science and Engineering in 2007.
- The head of the Program Division “Nanotribology” has been Honorary Professor in the Department of Physics since 2008.

Since the last evaluation the following persons became professors at Saarland University:

- The Scientific Director and head of the Program Division “Dynamic Biomaterials” was jointly appointed W3 Full Professor for Materials Synthesis in the Department of Chemistry in 2015. The former Scientific Director retired in 2010.
- The head of the Program Division “Energy Materials” was jointly appointed W3 Full Professor for Energy Materials in the Department of Materials Science and Engineering in 2015. Before he had been W1 Junior Professor since 2012.
- The head of the Program Division “Structure Formation” was jointly appointed W3 Full Professor for Colloids and Interface Chemistry in the Department of Chemistry in 2016.
- The head of the Program Division “Electron Microscopy” has been Honorary Professor in the Department of Physics since 2013.
- The head of the Junior Research Group “Cytoskeletal Fibers” was appointed W1 Junior Professor of Biological Physics at Saarland University in 2013, the joint appointment with INM took place in January 2017.

INM performs 40 to 50 individual cooperation projects with Saarland University each year. Three group leaders from INM participate in the Collaborative Research Center SFB 1027 “Physical modeling of non-equilibrium processes in biological systems”, which is coordinated by Saarland University. Furthermore, since 2013, the institute appoints INM Fellows, who receive funding for a joint research project with Saarland University (see chapter 2).

Members of INM contribute to the teaching at Saarland University. In a typical semester, lectures and student laboratories in the dimension of 20 academic hours per week are offered to students of about 15 different study programs.

Collaboration with other domestic and international institutions

Between 2014 and 2016, INM has maintained scientific contact (joint publications or funding) with more than 60 universities in Germany and abroad as well as with more than 40 research facilities. According to INM, particularly strong academic links exist to Cambridge University (UK), the University of Barcelona (Spain), the University of California in Santa Barbara (USA), the Georgia Institute of Technology (USA), Harvard University (USA), Drexel University (USA), University of South Australia in Adelaide (Australia), University of Luxembourg, and Université Paris-Sud XI (France).

Within the Leibniz Association INM coordinates the Leibniz Research Alliance “Nanosafety”, in which six more Leibniz institutes participate (see chapter 3). INM is member of

the Leibniz Research Alliance "Healthcare Technology" and INMs Junior Research Group "Switchable Microfluidics" is part of the Leibniz Research Cluster (LRC) "Bio/synthetic multifunctional meso-production units" funded by the BMBF 2020+ Biotechnology initiative. Furthermore, INM coordinates the Leibniz Network Nano, which includes 16 Leibniz institutes with expertise in nanotechnology or related fields.

Outside the Leibniz Association, INM cooperates with the *Steinbeis Forschungszentrum Material Engineering Center Saarland* (MECS), Saarbrücken, the *German Research Center for Artificial Intelligence* (DFKI), Saarbrücken, and the *German Cancer Research Center* (DKFZ), Heidelberg.

Within the framework of Horizon 2020, INM is a member of the EU-FET Project "Mechanocontrol of Biological Function" (2017-2020) and INM is task leader in the NanoReg2 project, in which 42 European institutions address regulatory aspects of nanosafety. INM partners with the *Centro Tecnológico LUREDERRA*, Spain, and the *TWI Technological Group*, UK, within the EU project "Infinity" (development of indium-free, transparent and conductive oxides for electronics). Also, INM is member of two *European International Training Networks*: Biosmart Trainee (bio-inspired designs for switchable adhesive materials) and MULTIMAT (novel building blocks, superporous materials and novel tools for in-situ imaging and molecular modeling).

Between 2014 and 2016, about 30 visiting scientists and students from 16 different countries enjoyed long-term guest residencies at INM. In the same period, more than 110 members of INM stayed at other host institutions, more than half of them in non-European countries.

Other collaborations and networks

INM is involved in national networks such as the *cc-NanoBioNet*, the *German Association of Nanotechnology*, and the *Nano in Germany* Initiative. INM contributes to the regional network *NanoPharm* and the *CaMPlusQ* – Forschungscampus Materialien, Prozesse und Qualifizierung (Research Campus for Materials, Processes and Qualification) at Saarland University. INM is also member of the Network *nanoInk*.

In an international cooperation with the *University of South Australia*, a DAAD network was established in 2016. The network is coordinated by the *University of Bayreuth* and supports student ex-change between the partners. INM is a partner in an InterReg project that brings together groups from Belgium, Luxembourg, Rhineland-Palatinate, and Saarland (ImproveSTEM, 2017-2020).

5. Staff development and promotion of junior researchers

Staff development and personnel structure

On 31 December 2016, INM had a total of 241 employees under contract (185 in 2009). Among these were 74 scientists, 41 doctoral students and 35 laboratory technicians (see appendix 4). Including all persons with access to the institute, i. e. Bachelor, Master students and scholarship holders, INM accommodates 274 persons (40% more than in

2009). INM expects further increase in the coming years, as indicates the volume of externally funded projects.

Approximately 37% of the scientists and 77% of the technical lab staff are currently employed on a permanent basis. The transition from a fixed-term to a permanent employment status for scientists hinges on a clear strategic need of the scientific, methodological or technological expertise of the co-worker for the institute. A formal appointment procedure was established which is initiated by one of the directors and includes reference letters from external experts. Scientists with a foreign nationality represent 51% of INM's scientific staff.

Promotion of gender equality

On 31 December 2016, 48 of the 115 employees in research and scientific services were women (42 %). Of the eleven group leaders (nine Program Divisions and two Junior Research Groups) three were female (27 %), one of them a Scientific Director of INM. 48 % of the scientists in non-executive positions and 39 % of the doctoral students were female.

The basis of INM's commitment to gender equality is the individual agreement of 2005 with the State of Saarland, on the application of the Agreement of Implementation of Equal Opportunities (AV-Glei). The institute complies with the Research-Oriented Gender Equality Standards of the German Research Foundation (DFG). INM has established target quotas for the scientific personnel (Leibniz-internal “Kaskadenmodell”). The institute has a gender equality plan (“Gleichstellungsplan”).

Gender equality is considered a management task at INM, and is under the responsibility of the directors. INM has an equal opportunities officer and a deputy who are elected by the female employees. The institute uses active recruiting, e. g. from databases of female scientists, forwards job advertisements to women-specific networks, and specifically addresses suitable female applicants.

In 2012 and 2015, INM was certified and re-certified with the audit *berufundfamilie*, which is a formal certification for family-friendly and life-phase conscious personnel management.

Promotion of junior researchers

Between 2014 and 2016, 14 students completed their doctorate (five of them in former groups not listed in chapter 4). The number of ongoing doctoral projects is 42 (31 December 2016). Since the last evaluation, the median duration of a doctoral thesis was 3.9 years. Doctoral students are paid initially at a level of 50% (E 13 TV-L). After at least one year and the publication of a paper as lead author, the students are paid at a level of 60%, in case of outstanding achievements and after a minimum of two years at 75%.

Postdoctoral scientists work on research projects but are also involved in developing the scientific profile of the group and in the initiation of external cooperation. INM group leaders involve postdoctoral scientists in project management and student supervision. INM expects and supports postdoctoral scientists to publish during their stay at INM and

to write proposals for their own research projects eventually. Exceptional candidates have the opportunity to become project leaders or Junior Research Group leaders.

One former group leader now holds a professorship at the University of Stuttgart. Other former scientists now hold positions also in academia (RWTH Aachen, Korea University of Technology and Education, University of Applied Science Furtwangen, Wageningen University) or industry (Dillinger Hütte, Bosch). Furthermore, two junior scientists declined offers from other universities and obtained Full Professor (W3) status in joint appointments with Saarland University.

Vocational training for non-academic staff

INM offers traineeships to become chemical laboratory assistants, industrial mechanics, electricians, IT specialists and industrial management assistants. Between 2014 and 2016, five traineeships successfully were completed. There are currently six trainees at INM.

6. Quality assurance

Internal quality management

INM has various mechanisms for monitoring the quality of results. All publications, patent applications, project proposals and reports are reviewed and approved by the Board of Directors prior to submission. The progress of the groups is reviewed annually in status meetings of the Board of Directors and the group leaders. Industrial projects are assessed in milestone meetings. At the weekly Jour Fixe meetings, the leading scientists discuss new project ideas, funding calls and pending proposals. Outgoing manuscripts are inspected by the Project Support & Technology Transfer group for patentable ideas. In 2012, INM appointed an ombudsperson for good scientific practice.

A performance-based allocation of research funds (Leistungsorientierte Mittelvergabe, LOM) was established in 2010. Since then, the proportion and volume of the funds allocated on a performance basis have been gradually increased. In 2016, the groups were allocated funds totalling € 630,000 based on LOM. The criteria are the number of full-time equivalents of scientists from basic funding, the peer-reviewed publications published in the previous two years, and the revenue obtained from external funding in the previous two years.

Quality management by the Scientific Advisory Board

The Scientific Advisory Board advises INM and its bodies on scientific and structural questions. Its advice and decision making includes the program budget, the multi-year research and development program, and cooperation with scientific institutions and industry. The Scientific Advisory Board consists of up to twelve external experts from Germany and abroad who are active in science and industry in INM's various fields of activity. The Scientific Advisory Board meets twice a year and assesses the research and planning of the whole institute in an audit at least once between two evaluations.

Implementation of recommendations from the last external evaluation

In the following, brief explanations will be provided with regard to the implementation of the recommendations in the evaluation report dated 20 September, 2010 (printed in italics below):

1. *Interdisciplinary cooperation between Research Fields and groups should be further strengthened over the next years.*

According to INM, it has intensified the cooperation between the groups. As a new mechanism, internal collaborative projects (Focus Projects) were initiated by the directors in 2013, 2015 and 2016. Up to now, funding has been provided for 16 projects for a total amount of approx. 1.23 M€. About 15.4 % (2016) of INMs publications are co-authored by members of different groups and several third party funding grants were acquired in cooperation.

2. *In view of the clear potential for development of the vast majority of the groups, a further quantitative and qualitative increase in publications is to be expected. INM should continue to further promote that positive trend.*

Since the last evaluation, INM scientists have increased the number of peer-reviewed publications from 68 (in 2010) to 110 (in 2016). The goal of one publication per full-time equivalent scientist per year is regularly exceeded. At the same time, the average impact factor was more than doubled, to a value of about 5.6. For reasons of visibility, the institute focuses almost exclusively on peer-reviewed journal publications.

3. *It is important to ensure that the fundamental and application-oriented scientific work that was being neglected prior to the previous evaluation is given time to develop so that a basis for spin-offs that is sustainable in the long term can evolve. The opinion forwarded at the evaluation visit by the representative of the responsible department at Länder level that for the future of the INM it would be desirable to generate more spin-offs than in previous years is shortsighted. Also, the review board disagrees with the implication that INM has generated too few spin-offs since the last evaluation. On the contrary, the current low number of spin-offs is inevitable. All persons in charge of INM must be aware that a return to the former culture which was geared towards rapid utilisation does not lead to a sustainable development and falls short of the tasks of the institute.*

Since the last evaluation, INM has concentrated on developing and consolidating its scientific basis. Following this recommendation, INM's scientific visibility increased in recent years. In the meantime, INM has succeeded in procuring industrial projects in newly-established areas, e. g. for robotic handling, steel analytics or cosmetics. The founding of a start-up company is currently being pursued.

4. *Following a recommendation of the last evaluation, INM has implemented mechanisms for innovation controlling. This should be taken further. For example, relating to market analyses, the institute should systematically investigate the requirements of industry sectors for research at the institute. Regular checks should also be carried out, in accordance with the fundamental objectives of INM, to determine the point in time at which continued*

development of a prototype product is no longer profitable or no longer within the remit of the institute. The development of market-ready products should be entrusted to companies.

INM has continued to extend its innovation controlling since the last evaluation. A systematic mechanism for patent assessment, before and after the filing process, was implemented to increase the effectiveness of INM's inventions. Systematic transfer activities were strengthened through the establishment of the InnovationCenter INM where the research activities in collaboration with industrial partners are coordinated and processed (see chapter 2).

5. *Within the context of the anticipated scientific consolidation of INM, efforts should be made to further increase the number of doctoral students at the institute, which is currently adequate at 25.*

INM now employs seven (2010: three) group leaders that hold professorships at Saarland University and can act as official thesis advisors. This led to an increase in the number of doctoral students (42 on 31 December, 2016, see Chapter 5).

6. *It is welcomed that there is a visible trend towards shortening the average length of doctoral study, which is currently 4.5 years.*

In the period since the last evaluation, the median duration of doctoral study was 3.9 years. The duration is counted from the beginning of the first employment contract as doctoral student at INM to the submission of the thesis at the university.

7. *The administration provided a great deal of support for the reorganisation of INM, which is evident from its new approach to patents, for example. Here and in the complex subject of innovation controlling, it should always be borne in mind that the activities carried out by the administration are to be determined by the scientific objectives of INM and should serve to fulfill these objectives.*

The administration is today closely linked to the scientific objectives of INM. Following two new appointments to the position of the Business Director in 2010 and in 2014, several reorganizations within the administration were implemented. For example, the former Patents, Licenses, Contracts group was developed into the Project Support & Technology Transfer group, with new mechanisms for innovation management and monitoring of the patent portfolio.

8. *The supervision of the INM carried out by its Board of Trustees is appropriate. In 2006, the representative of the responsible departments at Länder and at Federal level agreed on the necessity to reorganize INM as recommended by the previous evaluation. The funding bodies should maintain this view and should therefore provide continued support for the sustainable development of the institute. Spin-offs are not to be expected in the short-term.*

INMs directors agree with this recommendation.

9. *The plans to introduce performance-based funding are welcomed and should be pursued further.*

The system for performance-related funding was established at INM in 2010 and has been refined during the following years. In the view of INM, the system has proven its worth and should be continued.

10. *As has also been envisaged by the institute, efforts must be made to secure more third-party funding for research. As a minimum, the amount of funding received from the DFG must be sufficient to cover the corresponding charges.*

Since 2010, the revenue from project grants has, with the exception of a slight decrease in 2011, seen continual increases, and doubled to around 5.6 M€ (2016). The institute succeeded in obtaining sufficient funding to cover the DFG-charges in 2016 (for details see Appendix 3). Additional DFG funds have already been secured for the next years with the recent participation in the Collaborative Research Center (SFB 1027).

11. *The second Scientific Director will retire in mid-2010. In order to further consolidate INM, it is important that the ongoing procedure for a joint appointment with Saarland University is brought to a conclusion as soon as possible.*

INM has made three full search attempts in collaboration with Saarland University to hire a second Scientific Director. For different reasons, it proved difficult to successfully complete an appointment before 2015. In 2015, INM appointed a new second Scientific Director. The new director expands the materials chemistry expertise at INM and is in the process of fully establishing the Research Field Biointerfaces.

12. *As has been envisaged by the institute, the vacant group leader position in the Program Division Modeling/Simulation should be filled as soon as possible.*

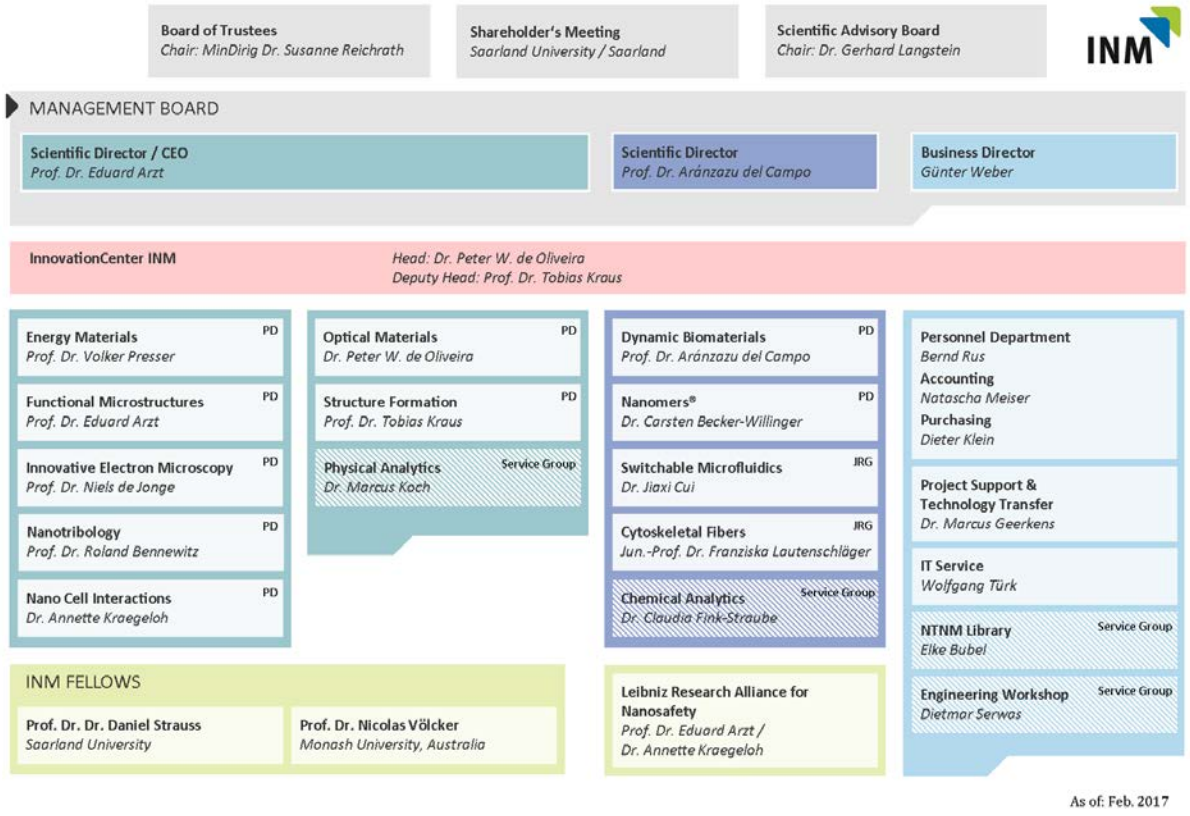
In spite of multiple hiring campaigns, INM has not succeeded in filling the group leader position in the Program Division Modeling/Simulation. Modeling has become an important subject and has been covered in several collaborations with external partners. In 2016, the directors decided to implement international cooperation on this topic on a larger scale and to no longer pursue the personalization of this group at INM. The cooperation cluster currently involves colleagues at Cambridge University, UC Santa Barbara and University of British Columbia as well as at Saarland University.

13. *INM should make further efforts to increase the number of female scientists in leading positions.*

INM appointed two female scientists to leading positions: The new second Scientific Director, and a head of a Junior Research Group. The proportion of women scientists was increased from 29 to 43% .

Appendix 1

Organisational Chart



Appendix 2

Publications and patents

Type of publication	2014	2015	2016
Articles in peer-reviewed journals	89	101	110
Individual contributions to edited volumes	37	36	26
Other publications	14	9	8

Industrial property rights (2014-2016)	Granted	Filed
Patent families	13	17
Other intellectual property rights	5	0
License contracts	27	

Appendix 3 Revenue and Expenditure

Revenue		2014			2015			2016 [1]		
		k€	% [2]	% [3]	k€	% [2]	% [3]	k€	% [2]	% [3]
Total revenue (sum of I., II. and III.; excluding DFG fees)		**21,069.2**			**23,165.2**			**23,464.5**		
I.	**Revenue (sum of I.1.; I.2., and I.3.)**	**20,898.7**	100%		**22,946.1**	100%		**23,203.7**	100%	
1.	Institutional funding (excluding construction projects and acquisition of property)	16,293.8	78%		17,977.2	78%		17,620.8	76%	
1.1	Institutional funding (excluding construction projects and acquisition of property) by Federal and *Länder* governments according to AV-WGL	16,293.8			17,977.2			17,620.8		
1.2	Institutional funding (excluding construction projects and acquisition of property) not received in accordance with AV-WGL	0.0			0.0			0.0		
2.	Revenue from project grants	4,258.5	20%	100%	4,516.4	20%	100%	5,084.0	22%	100%
2.1	DFG	302.0		7%	383.8		9%	440.9		9%
2.2	Leibniz Association (competitive procedure)	180.4		4%	249.4		6%	744.8		15%
2.3	Federal, *Länder* governments	1,969.5		46%	1,848.0		41%	1,377.1		27%
2.4	EU	581.8		14%	728.3		16%	1,019.6		20%
2.5	Industry	952.5		22%	1,190.3		26%	1,407.4		28%
2.6	Foundations	192.5		5%	52.3		1%	19.6		0%
2.7	Other sponsors	79.8		2%	64.3		1%	74.6		1%
3.	Revenue from services	346.4	2%		452.5	2%		498.9	2%	
3.1	Revenue from commissioned work	0.0			0.0			0.0		
3.2	Revenue from publications	0.0			0.0			0.0		
3.3	Revenue from exploitation of intellectual property for which the institution holds industrial property rights (patents, utility models, etc.)	346.4			452.5			498.9		
3.4	Revenue from exploitation of intellectual property without industrial property rights	0.0			0.0			0.0		
3.5	*Revenue from other services*	0.0			0.0			0.0		
II.	**Miscellaneous revenue** (e. g. membership fees, donations, rental income, funds drawn from reserves)	**170.5**			**219.1**			**260.8**		
III.	**Revenue for construction projects** (institutional funding by Federal and *Länder* governments, EU structural funds, etc.)	**0.0**			**0.0**			**0.0**		

Expenditures		k€	k€	k€
Expenditures (excluding DFG fees)		**21,069.2**	**23,165.2**	**23,464.5**
1.	Personnel	10,285.6	10,549.5	11,524.5
2.	Material expenses	6,510.4	6,994.4	6,541.5
2.1	*Proportion of these expenditures used for registering industrial property rights (patents, utility models, etc.)*	*817.3*	*714.7*	*699.7*
3.	Equipment investments	4,649.8	5,726.7	4,559.6
4.	Construction projects, acquisition of property	0.0	0.0	0.0
5.	Other operating expenses (cash assets, bonded funds, accrued and deferred items)	-376.6	-105.4	838.9

DFG fees (if paid for the institution - 2.5 % of revenue from institutional funding)	406.4	418.6	422.2

[1] Preliminary data: ~~yes~~/no

[2] Figures I.1., I.2. und I.3. add up to 100 %. The information requested here is thus the percentage of "Institutional funding (excluding construction projects and acquisition of property)" in relation to "Revenue from project grants" and "Revenue from services".

[3] Figures I.2.1 bis I.2.7 add up to 100 %. The information requested here is thus the percentage of the various sources of "Revenue from project grants".

Appendix 4

Staff

(Basic financing and third-party funding / proportion of women (as of: 31 December 2016)

	Full time equivalents		Employees		Female employees	
	Total	on external funding	Total	on temporary contracts	Total	on temporary contracts
	Number	Percent	Number	Percent	Number	Percent
Research and scientific services	***93.6***	**43.5**	***115***	**75.7**	***48***	**83.3**
Professors / Direct. (C4, W3 or equi.)	4	50.0	4	25.0	1	
Professors / Direct. (C3, W2, A16 or equi.)						
Academic staff in executive positions (E15Ü, E15, E14 or equi.)	8	12,5	8	25,0	2	
Junior Research Group leaders / junior professors/ post-doctoral fellows (C1, W1, E14 or equivalent)	1	100	1	100		
Scientists in non-executive positions (A13, A14, E13, E14 or equivalent)	59.1	43.0	61	70.5	29	82.8
Doctoral students (A13, E13, E13/2 or equivalent)	21.4	52.8	41	100	16	100
Service positions	***48.2***		***51***			
Laboratory (E9 to E12)	15.1	33.2	16			
Laboratory (E5 to E8)	17.6	22.7	19			
Workshops (E9 to E12)	7		7			
Workshops (E5 to E8)	3		3			
Library (E9 to E12)	2		2			
Library (E5 to E8)	0.5		1			
Information technology - IT (from E13)	1		1			
Information technology - IT (E9 to E12)	1		1			
Information technology - IT (E5 to E8)	1		1			
Administration	***32.3***		***37***			
Head of the administration	1		1			
Staff positions (from E13, A13)	3.4		4			
Other staff positions/Secretaries (E9 to E 12)	4.9		5			
Other staff positions/Secretaries (E5 to E8)	3		4			
Internal administration (financial administration, personnel etc.) (from E13)	3	33.3	3			
Internal administration (financial administration, personnel etc.) (E9 to E12)	6.1		7			
Internal administration (financial administration, personnel etc.) (E5 to E8)	8.1	12.3	10			
Building service (E4 to E10)	2.8		3			
Student assistants	***9.7***	***24.1***	***32***			
Trainees	***6***		***6***			
Scholarship recipients at the institution	***3 / 9[1]***		***3***		***1***	
Doctoral students	1	1	1			
Post-doctoral researchers	2	2	2		1	

[1] Three scholarship recipients only with admittance agreement, six also with work contract.

7 November 2017

Annex B: Evaluation Report

INM – Leibniz Institute for New Materials, Saarbrücken

Contents

1. Summary and main recommendations

The INM – Leibniz Institute for New Materials is an excellent research institution working in the field of basic and applied material research. It uses an interdisciplinary approach involving physics, chemistry and biology to investigate interface and surface phenomena. On the basis of its results, innovative technologies are developed up to pilot plant scale and successfully transferred to applications together with partners in industry.

At the evaluation before last in 2005/2006, INM was evaluated very critically by the Leibniz Association Senate, which led to a further evaluation just four years later. Under the current Scientific Director, who has held the position since 2007, INM has undergone remarkable reform; at the 2010/2011 evaluation, the Leibniz Senate acknowledged that the success of the institute's reorientation outstripped expectations. Since then, this positive development has been consistently maintained. Publication output has increased significantly, both in terms of quantity and quality, as has the volume of third-party income. INM has now become one of the world's leading institutes for material sciences.

INM's work is undertaken in three Research Fields with a total of nine Programme Divisions and two Junior Research Groups which are rated as "excellent" (twice), "very good to excellent" (three times), "very good" (three times), "good to very good" (twice) and "good" (once). With the establishment of the InnovationCenter INM in 2014, technology transfer to industry has been further professionalised. INM holds a remarkably large number of patents.

Since the last evaluation, it has been possible to recruit excellent scientists at INM and to retain highly successful junior researchers at the institute. Thanks to three new joint appointments, cooperation with Saarland University has been expanded substantially. Particular mention should be made of the appointment of the new Scientific Director and Head of Dynamic Biomaterials in 2015: the institute recruited a scientist with an outstanding reputation in biomaterials, which is a new field for INM, and thus set a very important new course for the institute's future development.

Special consideration should be given to the following main recommendations in the evaluation report (highlighted in **bold face** in the text):

<u>General concept and profile (Chapter 2):</u>

1. As recommended at the last evaluation, INM has increased cooperation between the groups. Introduced in 2013, the Focus Projects, which allow groups to receive additional funding for joint projects, have proven to be a suitable tool for this purpose. As planned, INM should continue to extend cooperation between the individual groups as interdisciplinary collaboration holds high potential for new scientific insights. This should also mean that the percentage of publications produced by more than one group will continue to increase.

2. As of 2020, INM plans to extend its work on "Materials in the Digital Environment" and "Biomedical Materials". In order to finance the additional equipment and personnel required, INM plans to register for a temporary extraordinary item of expenditure for the years 2020 to 2022. A total of €9.15 million will be required to finance the establishment of two Junior Research Groups as well as new laboratories with the appropriate equipment.

   To this project INM will contribute €1.65 million (3 %) of its core budget, whereas €7.5 million will remain to be covered by the Federal Government and the Länder. This equates to approx. €2.5 million per year. It is welcomed that, as of 2023, INM will meet the costs from its regular core budget. INM's plans are coherent and are expressly endorsed.

   In order to set up new laboratories, INM needs additional space. For this purpose, the *Saarland* will allow INM to annex a neighbouring building currently used by Saarland University rent free. It is welcomed that the university supports this plan. It will significantly improve INM's provision of space, which is currently very restricted.

3. The requirements imposed on INM to attract industrial funding are inadequate. Currently, the target for industrial funding is coupled with the income from public research funding (Government and *Länder*, DFG, EU and Leibniz Association). Due to its laudable success in acquiring public funding, this means that INM is forced to take on industrial projects that barely comply with its overall strategy.

   When formulating targets for industrial funding, the Board of Trustees, particularly the departments responsible at Federal and *Länder* level, should ensure that they match the scientific context. A comparison with similarly-focused Leibniz institutes could prove helpful.

<u>Collaboration and networking (Chapter 4)</u>

4. INM's and Saarland University's appointment procedures for joint professorships have been target-oriented and efficient. Under their cooperation agreement, INM and the university convene committees to prepare the appointments in accordance with their internal procedures and regulations. It should be examined whether, in future, joint appointment commissions with an equal number of representatives from each side could be convened as foreseen in the "Standards for the appointment of academic directors in the Leibniz Association".

5. Together with collaborative partners important modelling and simulation work is regularly conducted for INM. This is the appropriate solution INM found to not being able to fill the vacant group leader position in the Programme Division "Modelling/Simulation" as recommended at the last evaluation. INM should, however, continue its efforts to establish the relevant position at the institute in order to secure the necessary expertise long term.

Staff development and promotion of junior researchers (Chapter 5):

6. INM should ensure that all group leaders are well informed about the various options available for personnel development and that they utilise them. The institute should consider whether an annual performance review should be introduced. This could provide an appropriate setting for giving feedback to technical personnel on their contribution to the research results.
7. Since the last evaluation, INM has successfully increased the proportion of women in research and scientific services from 29 per cent to 42 per cent. It is particularly positive that INM has recruited two women at group leadership level in the last few years, one of them as a Scientific Director. Thus currently, three of the eleven group leaders are women. INM should continue to pursue this policy and keep increasing the proportion of women at group leadership level.

2. General concept and profile

Development of the institution

At the evaluation before last in 2005/2006, INM was evaluated very critically by the Leibniz Association Senate, which led to a further evaluation just four years later. At the time, there was felt to be a dearth of independent research work as a basis for innovative material developments and too much reliance on industrial contracts. Under the current Scientific Director, who has held the position since 2007, INM has undergone remarkable reform. In addition to the traditional fields of nanocomposite technology, the new focus areas of interface materials and biomaterials were adopted. Also, interdisciplinary fundamental research was extended. At the 2010/2011 evaluation, the Leibniz Senate confirmed that the success of the institute's reorientation outstripped expectations. Since then, this positive development has been consistently maintained, now making INM a world leader in material sciences.

The institute responded convincingly to the recommendations made at the last evaluation (see Chapter 6). Publication output has significantly increased once again, both in terms of quantity and quality, as has the volume of third-party income. Four very successful new Programme Divisions have been established, headed either by excellent, newly-recruited scientists or by extremely successful junior researchers who have been promoted to retain them at INM. Particular mention should be made of the appointment of the new Scientific Director and Head of Dynamic Biomaterials in 2015: the institute recruited a scientist with an outstanding reputation in biomaterials, which is a new field for INM. This appointment filled the position of one of the two Scientific Directors that had been vacant since 2010 and set a very important new course for the institute's future development. Moreover, INM established two highly-promising new Junior Research Groups and professionalised its technology transfer by founding the InnovationCenter INM in 2014 (see Chapter 3).

At the same time as establishing new groups, since the last evaluation, INM has ended three Programme Divisions and two Junior Research Groups. This was partly a result of successful group leaders accepting attractive job offers elsewhere (in one case a

professorship) and partly because it was decided to discontinue less successful research efforts. INM used the resources thus freed up for the new groups.

Results

Working results of the Programme Divisions and Junior Research Groups

INM's working results are produced by nine Programme Divisions and two Junior Research Groups which are assigned to three Research Fields.

In the Research Field "Interface Materials", which has been decisively shaped by the Scientific Director, two of the four Programme Divisions are rated as "excellent" and two as "very good to excellent". The Research Field strikes the balance between basic research and the transfer of its results to applications particularly well. In every respect, the results are outstanding.

The Research Field "Nanocomposite Technology" comprises topic areas that INM has addressed since it was originally founded. Its three Programme Divisions are rated as "very good, "good to very good" and "good". The work is strongly application related. In parts, its publication output and volume of third-party funding lag behind the other groups at INM.

In the Research Field "Biointerfaces", which is largely still in the process of being established by the new Scientific Director, the two Programme Divisions are rated as "very good to excellent" and "good to very good". Both Junior Research Groups are rated as "very good". The Research Field has enormous potential and is of major importance to INM's continued development. The performance indicators have already reached a very good level. Initially, fewer industrially-useful results are to be expected as the current focus is quite rightly on basic research.

As recommended at the last evaluation, INM has increased cooperation between the groups. Introduced in 2013, the Focus Projects, which allow groups to receive additional funding for joint projects, have proven to be a suitable tool for this purpose. As planned, INM should continue to extend cooperation between the individual groups as interdisciplinary collaboration holds high potential for new scientific insights. This should also mean that the percentage of publications produced by more than one group will continue to increase.

Technology transfer and patents strategy

Building on its research results, INM is very good at developing innovative technologies and transferring them to applications. Thanks to the InnovationCenter INM, established in 2014, the interlinking of INM's work with potential industrial partners has been professionalised further (see Chapter 3.).

INM holds a large number of patents (476 in 73 patent families) and pursues a very convincing patents strategy. Results are systematically examined for their application potential. The existing patent portfolio is also checked regularly with less promising patents not being extended. Due to its innovative developments and processes, INM is a

coveted partner for collaborations with industry, a fact that is reflected in the concomitant acquisition of third-party funding (see below).

It is very positive that a spin-off is currently being planned in connection with the Gecomer®-technology developed by INM. The development of this technology illustrates how important it is for an institute to initially conduct basic research of its own in order to be able to build on it and develop innovative applications. Against this backdrop, it is welcomed that the *Land* which hosts the institute acted on the recommendation made at the last evaluation and no longer expects the institute to produce industrially utilisable results and spin-offs in the shortest time possible.

Strategic work planning for the next few years

INM's planning for the next few years is convincing. Until 2020, work will initially focus on four key topics (Contact Engineering, Electroactive Interfaces, 4D Materials and Nanocomposites, Cell-Materials Interaction). **As of 2020, INM plans to extend its work on "Materials in the Digital Environment" and "Biomedical Materials".** Research into "Materials in the Digital Environment" will cover four areas: Soft human-centred electronics, Mobile energy harvesting, Integration of optical IDs and Materials for haptics. The research topics addressed by "Biomedical Materials" will be: Tissue models for animal-free testing, Immuno-interactive scaffolds and Translational biomaterials. Very good plans are in place for involving the academic environment in Saarbrücken (see Chapter 4).

In order to finance the additional equipment and personnel required, INM plans to register for a temporary extraordinary item of expenditure for the years 2020 to 2022. A total of €9.15 million will be required to finance the establishment of two Junior Research Groups as well as new laboratories with the appropriate equipment. The costs break down as follows:

- €1.65 million for a start-up grant for two Junior Research Groups (five persons each)
- €4.5 million for 900 m² of laboratories (equipment and infrastructure)
- €2.5 million for large-scale equipment
- €0.5 million for 500 m² of offices and work space

To this project INM will contribute €1.65 million (3 %) of its core budget, whereas €7.5 million will remain to be covered by the Federal Government and the *Länder*. This equates to approx. €2.5 million per year. It is welcomed that, as of 2023, INM will meet the costs from its regular core budget. INM's plans are coherent and are expressly endorsed.

In order to set up new laboratories, INM needs additional space. For this purpose, the *Saarland* will allow INM to annex a neighbouring building currently used by Saarland University rent free. It is welcomed that the university supports this plan. It will significantly improve INM's provision of space, which is currently very restricted.

Appropriateness of funding, facilities and equipment

At €17.6 million, institutional funding is sufficient to allow INM to fulfil its current portfolio of work. The institute is outstandingly well equipped, which considerably enhances its attractiveness as a workplace both for senior and junior researchers.

As recommended, revenue from project grants has been increased; at €5.1 million it now accounts for twice the sum at the last evaluation. The major proportion of revenue from project grants derives from the Federal Government and the *Länder* although INM's industrial funding volume is also very high. Particular mention should be made of the ERC Advanced Grant acquired by INM's Scientific Director. And it is welcomed that in 2016, DFG fees were also recouped for the first time, as recommended at the last evaluation. With three individual projects, which will run from 2017 to 2020 in the context of the DFG-funded Collaborative Research Centre (SFB 1027) "Physical modeling of non-equilibrium processes in biological systems", the scene is set for this to continue in the longer term.

The requirements imposed on INM to attract industrial funding are inadequate. Currently, the target for industrial funding is coupled with the income from public research funding (Government and *Länder,* DFG, EU and Leibniz Association). Due to its laudable success in acquiring public funding, this means that INM is forced to take on industrial projects that barely comply with its overall strategy.

When formulating targets for industrial funding, the Board of Trustees, particularly the departments responsible at Federal and *Länder* level, should ensure that they match the scientific context. A comparison with similarly-focused Leibniz institutes could prove helpful.

INM's relatively high income from exploiting intellectual property rights is welcomed. In 2016, it was almost €0.5 million and was consequently almost as high as the sum required to register patents (€0.7 million).

3. Subdivisions of INM

3.1 Research Field "Interface Materials"

3.1.1 Programme Division "Energy Materials"

(5 FTE research and scientific services, 4.15 FTE doctoral students, 1 FTE technical lab staff)

This Programme Division is extremely successful in developing and investigating functional materials for electrochemical applications. Its work is very innovative and meets the highest scientific standards. The group was established as a Junior Research Group with funding from the Federal Ministry of Education and Research in 2012, the group leader being appointed to a junior professorship (W1) at Saarland University. It is very pleasing that the head of the group chose to remain at the institute despite being offered a professorship at another university. He was then appointed to a full professorship (W3) at Saarland University and the Junior Research Group became a Programme Division.

Research focuses on synthesising novel carbon and hybrid materials ranging from carbon onions of a few nanometres to mm-sized monoliths, which are used as functional electrode materials. The group employs various innovative material characterisation techniques and combines these with in-situ methods. Its outstanding research results form the basis for new materials which are of use in energy storage (batteries and supercapacitors), recovery and harvesting, and electro-chemical water treatment. The Programme Division's excellent performance is reflected in its publication record and third-party income.

The Programme Division is rated as "excellent".

3.1.2 Programme Division "Functional Microstructures"

(8.5 FTE research and scientific services, 2.6 FTE doctoral students, 6.1 FTE technical lab staff)

Established in 2007, this Programme Division conducts top-level research on novel functional surfaces. Building on excellent, internationally-leading basic research, the Programme Division develops innovative applications and transfers them to industrial exploitation in an exemplary fashion. The model for the structures created and their innovative functions are inspired by nature and transferred to artificial systems. Efforts focus on switchable adhesion to different surfaces using the Gecomer®-structures patented by INM.

This outstanding experimental work is ideally supplemented by numerical simulations and modelling which are conducted jointly with two internationally-renowned scientists from the University of Cambridge and UC Santa Barbara. The research findings are published in high-ranking international journals and are also used as the basis for developing diverse applications ranging from technical gripping systems to surfaces for medical use. Third-party income is very high including, amongst others, an ERC Advanced Grant (2014-2019). Under the Leibniz Competition, the group also managed to acquire funding for the InnovationCenter INM (2016-2019) to transfer the Gecomer® technology to industrial applications. INM already holds various patents in this context and is preparing a spin-off (see Chapter 2).

The Programme Division is rated as "excellent".

3.1.3 Programme Division "Nanotribology"

(5 FTE research and scientific services, 1.18 FTE doctoral students)

Established in 2008, this Programme Division extremely successfully investigates the nanomechanical properties of materials. It has pioneered the field of electrochemical friction control and is one of the world leaders in research into the microscopic mechanisms of friction and wear. In 2014, the head of the group chaired the renowned international Gordon Research Conference in Tribology.

The group's core method is high-resolution atomic force microscopy, but it also develops other innovative processes and researches novel materials, such as graphene. Based on its excellent research results and long-term experience, its extensive expertise in friction

measurement is now also applied to the new and scientifically-exciting field of haptics and surface cognition, investigating, amongst others, how brain activity changes in response to friction stimuli of the skin. This explorative work generates very promising connections to groups in the Research Field "Biointerfaces". The overall publication record is very good, even though 2016 saw relatively few publications. The volume of third-party funding income is also appropriate. Between 2013 and 2015, the group managed to acquire one DFG project per year. It was thus instrumental in enabling INM to recoup its DFG fees for the first time in 2016.

The Programme Division is rated as "very good to excellent".

3.1.4 Programme Division "Electron Microscopy"

(4 FTE research and scientific services, 0.5 FTE doctoral students, 1 FTE technical lab staff)

Established in 2012, this Programme Division pursues top-level interdisciplinary research at the interface of the electron microscopy, biophysics, materials science, and image processing. The Programme Division is one of the world's leading groups in the field of in-situ and liquid-phase scanning transmission electron microscopy (STEM). One of its special strengths lies in the creative way it develops techniques to facilitate the investigation of functional materials and biological systems under real conditions. Special mention should be made of in-situ studies on the growth of nanoscale gold dendrites in a liquid thin film or the studies at single molecule and single cell level of growth factor receptors in cancer cells.

The group's outstanding research results are reflected in a wealth of high-quality publications in international journals. Third-party income is appropriate and was raised, in particular, in the Leibniz Competition. As of 2017, the group will, moreover, be involved in the DFG-funded Collaborative Research Centre 1027. It is already of great importance to other groups at INM and should, as planned, be even more intensively interconnected within INM.

The Programme Division is rated as "very good to excellent".

3.2 Research Field "Nanocomposite Technology"

3.2.1 Programme Division "Nanomers"

(7.23 FTE research and scientific services, 0.5 FTE doctoral students, 3.86 FTE technical lab staff)

The strongly application-related work conducted in this Programme Division since 2001 addresses the development of nanocomposite-based multifunctional protective coatings and compact materials. The group's priority is to make new material properties utilisable for industrial exploitation, whereby the fields of application are very diverse. It is welcomed that between 2014 and 2016, five patents were filed and funding was successfully acquired from industry. However, very little additional funding was raised and the number of publications is relatively low, especially in reviewed journals.

If the group is to remain competitive it must now develop more innovative research questions. It is welcomed that INM management is aware of this and plans to re-

orientate the group in cooperation with its leader. INM's newly-planned fields of work (see Chapter 2) provide very good opportunities for doing so.

The Programme Division is rated as "good".

3.2.2 Programme Division "Optical Materials"

(10.89 FTE research and scientific services, 2.6 FTE doctoral students, 7 FTE technical lab staff)

Research in this Programme Division, which was established in 2005, focuses on innovative coating materials with special properties which function on the basis of interaction with electromagnetic radiation. The group has developed, for example, novel printing ink based on innovative transparent conducting materials, functional coating systems for the surface treatment of household appliances and glass-like coatings with optimised biocompatibility for cardiovascular implants. Building on its own fundamental research, the group has developed and optimised novel technologies. Amongst recent results, special mention should be made of the work on photochemical metalisation.

The group is strongly application oriented and cooperates with many partners in industry, which is reflected in the concomitant third-party income. Third-party funding has, however, also been acquired from the Federation and the *Länder* as well as the EU. Between 2014 and 2016, five patents were filed and eight granted; this figure is high. The group's good research results are published appropriately in reviewed journals.

The head of the group is also the head of the InnovationCenter INM (see below). It is welcomed that, in the future, he will be able to devote his energies to this enormous task as a new leader will be sought to head the Programme Division. This leadership position should be filled with an eye to INM's newly-planned areas of work (see Chapter 2).

The Programme Division is rated as "good to very good".

3.2.3 Programme Division "Structure Formation"

(4 FTE research and scientific services, 3.4 FTE doctoral students, 3 FTE technical lab staff)

This Programme Division investigates the mechanisms of structure formation and uses its results to produce novel structured nanocomposites. The group was originally created as a Junior Research Group in 2008 and was so successful that it was made into a Programme Division in 2014. The scope of its work ranges from studies into basic physical concepts via modelling to developing new materials with improved functionality. The in-situ characterisation techniques employed in these efforts are more than state-of-the-art. Examples of applications include sinter-free inks and transparent conductive electrodes.

The group's overall publication record is very good and its third-party income is high. Apart from acquiring funding from the Federal and *Länder* Governments, special mention should be made of DFG projects. It is welcomed that the group leader was appointed to a joint professorship (W3) with Saarland University in 2016 and thus remained at INM despite having been offered a professorship by another university. He

is also deputy head of the InnovationCenter INM (see below), a dual function that considerably increases his workload.

The Programme Division is rated as “very good”.

3.3 Research Field “Biointerfaces”

3.3.1 Programme Division “Dynamic Biomaterials”

(12 FTE research and scientific services, 4.14 FTE doctoral students, 0.7 FTE technical lab staff, 1 FTE Post-doctoral scholarship recipient)

This Programme Division was established in September 2015 with the appointment of the new Scientific Director and head of the Programme Division. She is one of the world leaders in the field of biomaterials. The group’s research focuses on the use of light to modulate properties of biomaterials and to provide specific signals to embedded cells on demand and with spatiotemporal resolution. The excellent results form the basis for innovative medical applications in tissue engineering and tissue models.

In 2016, substantial initial results were published and a certain volume of third-party funding was raised. As of 2017 the group will be involved in the DFG-funded Collaborative Research Centre 1027. The plans for continuing to develop the group are convincing and should mean that the extremely high scientific potential will generate outstanding results, as has already been the case in certain areas during the short time in which the group has existed. The group is at the very heart of INM’s future work focus and is thus of great importance for the development of the entire institute.

The Programme Division is rated as “very good to excellent”.

3.3.2 Junior Research Group “Switchable Microfluids”

(2 FTE research and scientific services, 0.86 FTE doctoral students, 1 FTE technical lab staff, 1 FTE Post-doctoral scholarship recipient)

This Junior Research Group was established in September 2015 and is part of the BMBF-funded Leibniz Research Cluster (LRC) “Bio/synthetic multifunctional meso-production units” that integrates five Junior Research Groups at five Leibniz Institutes. The group successfully develops and synthesises new intelligent materials which can change their properties in response to external influences. Despite a relatively modest number of staff, within a short time, the group has produced its first notable results, such as the design of new chemistries and fabrication approaches to externally control the liquid segregation within polymeric networks in time and space. Since 2016, these results have been finding their way into very good publications. The group fits extremely well with INM’s future focus and already cooperates closely with other groups. Thanks to the LRC, it is also very well connected with the other Leibniz institutes involved. Overall, the group has great potential and should continue down the path it has staked out.

The Junior Research Group is rated as “very good”.

3.3.3 Junior Research Group "Cytoskeletal Fibres"

(Established in January 2017, no personnel as of 31 December 2016)

The head of this group became a W1 Junior Professor of Biological Physics at Saarland University in 2013 and joined INM in January 2017. She holds a fixed-term joint appointment until 2020. The group successfully investigates the properties and impact of cytoskeletal components (actin fibres and intermediate filaments) on cellular functions. As this group has a biophysical bias it fits together excellently with the chemistry-oriented groups conducting complementary research in the field. The very good work that was done at Saarland University is now being coherently continued at INM. The group employs state-of-the-art imaging techniques, know-how from which other groups benefit. It is welcomed that, as of 2017, the junior group is involved in the DFG-funded Collaborative Research Centre 1027. This provides a basis for intensifying the promising cooperation, in particular with the Programme Division "Dynamic Biomaterials" (see above). Overall, the group has very high potential.

The Junior Research Group is rated as "very good".

3.3.4 Programme Division "Nano Cell Interactions"

(3 FTE research and scientific services, 1 FTE doctoral students, 2 FTE technical lab staff)

This Programme Division successfully studies the effects of technically-produced nano objects on human cells. It was established in 2008 as a Junior Research Group and became a Programme Division in 2010. The group's interesting scientific work derives to a very considerable extent from the Leibniz Research Alliance for Nanosafety, which was established in 2012. Here it plays a central role; the group leader is also the coordinator. This alliance of six Leibniz Institutes aims to gain an in-depth understanding of nanoparticle-induced effects, to develop safe nanomaterials, to generate a digital data infrastructure for nanosafety and to analyse public perception of the field. Moreover, together with the InnovationCenter INM, the group is conducting the "Safe-by-Design" project which is part of the EU project "NanoReg II" in which 42 European institutions address regulatory aspects of nanosafety.

The topic of nanosafety is of major social and political relevance. Research of this kind is now being conducted in many places with considerably greater resources than at INM. Nonetheless, it is welcomed that INM contributes its enormous expertise in material sciences to the various networks and even does its own research on nanosecurity on a smaller scale. It should be examined whether it is possible to focus attention on a clearly-defined area in order to achieve a prominent position in that area. The Programme Division's results are published appropriately. Given the modest size of the division, it is successful in raising third-party funding. One of the group's strengths lies in its national and international connections from which the whole of INM benefits.

The Programme Division is rated as "good to very good".

3.4 Cross Linking Area "InnovationCenter INM"

(5.5 FTE research and scientific services, 0.5 FTE doctoral students, 3 FTE technical lab staff)

By establishing the InnovationCenter INM in 2014, the institute managed to professionalise and thus to increase the efficiency of transferring its scientific results and technological developments to industrial applications. Together with partners in industry, novel coating materials and new structuring techniques are developed right up to pilot plant scale. Furthermore, companies can come to INM to have the properties of materials analysed or access the institute's analytical equipment directly.

INM's visibility for potential collaborations with industry was enhanced yet further when the InnovationCenter INM was established, which is reflected in the increase in third-party funding from industry. When continuing to develop the centre, INM should come to an agreement with Saarland University which also has structures for promoting technology transfer. Extremely well-suited scientists were chosen to head the centre (see 3.2.2 and 3.2.3).

4. Collaboration and networking

Collaboration with Saarland University and within Saarbrücken

INM's cooperation with Saarland University is very good and has been substantially expanded since the last evaluation. At that time, only the two Scientific Directors held joint professorships (W3) with Saarland University. Since then, three joint W3 appointments have been made: In addition to the new Scientific Director appointed in 2015, two very successful young group leaders also received professorships in 2015 and 2016 respectively. Moreover, a W1 junior professor appointed by Saarland University in 2013, transferred to INM in 2017. The contribution of INM members to teaching at Saarland University is well above average.

INM's and Saarland University's appointment procedures for joint professorships have been target-oriented and efficient. Under their cooperation agreement, INM and the university convene committees to prepare the appointments in accordance with their internal procedures and regulations. It should be examined whether, in future, joint appointment commissions with an equal number of representatives from each side could be convened as foreseen in the "Standards for the appointment of academic directors in the Leibniz Association".

Many research projects are conducted jointly with Saarland University. Particular mention should be made of three INM group leaders' participation in the Collaborative Research Center SFB 1027, which has been funded by the DFG since 2017 and is coordinated by Saarland University. In the institute's collaboration with the university, the tool of INM Fellows, whereby scientists receive funding for a joint research project with INM researchers, have proved very effective. Since 2013, three fellows have been appointed at Saarland University (one still active) and one at Monash University in Melbourne, Australia (still active).

As a consequence of the planned extension of INM's portfolio (see Chapter 2), networking within the diverse research landscape of Saarbrücken will be intensified considerably once again. Collaboration is foreseen in the field of "Materials in the Digital Environment" with the renowned Saarland Informatics Campus, which not only embraces the Computer Science Department of Saarland University but also two Max Planck Institutes, the German Center for Artificial Intelligence and the Center for IT-Security, Privacy and Accountability. In the field of "Biomedical Materials" cooperation is planned with the Saarland University Medical Center, the Biophysics Center and the Helmholtz Institute for Pharmaceutical Research Saarland.

Collaboration within the Leibniz Association

Most of the institute's national collaborations are within the Leibniz Association where INM is very well connected. Staff at INM coordinate the Leibniz Research Alliance "Nanosafety", in which six Leibniz institutes and eight external partners participate, and the Leibniz Network "Nano", which includes 16 Leibniz institutes with expertise in nanotechnology or related fields (see 3.3.4). In addition, INM is also involved in the Leibniz Research Alliance "Healthcare Technology" (14 members). Furthermore, in the context of the BMBF-funded Leibniz Research Cluster "Bio/synthetic multifunctional meso-production units", the institute maintains close contacts with the other five Leibniz institutes involved (see 3.3.2).

International collaboration

Amongst INM's international collaborations, special mention should be made of cooperation with the University of Cambridge, UC Santa Barbara and the University of British Columbia. **Together with these institutions as well as with Saarland University important modelling and simulation work is regularly conducted for INM. This is the appropriate solution INM found to not being able to fill the vacant group leader position in the Programme Division "Modelling/Simulation" as recommended at the last evaluation. INM should, however, continue its efforts to establish the relevant position at the institute in order to secure the necessary expertise long term.**

INM is also connected with other foreign institutions through its participation, for example, in various EU projects within the framework of Horizon 2020. A further positive point is that since the last evaluation, three Humboldt award winners and six Humboldt fellows have been hosted by INM.

For collaborations with industry see Chapter 2.

5. Staff development and promotion of junior researchers

Staff development and personnel structure

INM's personnel structure is appropriate for its portfolio. The high proportion of scientists from abroad (51% of INM's scientific staff) is welcomed. The personnel decisions taken in the last few years with regard to the heads of the Programme Divisions were highly convincing. The institute has recruited outstanding,

internationally-recognised researchers and retained highly successful junior researchers. INM's established organisational structure, which involves flat hierarchies, is one of the main features making INM an attractive research location.

INM should ensure that all group leaders are well informed about the various options available for personnel development and that they utilise them. The institute should consider whether an annual performance review should be introduced. This could provide an appropriate setting for giving feedback to technical personnel on their contribution to the research results.

Promotion of gender equality

Since the last evaluation, INM has successfully increased the proportion of women in research and scientific services from 29 per cent to 42 per cent (reporting date: 31 December 2016)**. It is particularly positive that INM has recruited two women at group leadership level in the last few years, one of them as a Scientific Director. Thus currently, three of the eleven group leaders are women. INM should continue to pursue this policy and keep increasing the proportion of women at group leadership level.**

The tools available at the institute to promote the work-family balance are appropriate. This is illustrated by the fact that INM was awarded the *audit berufundfamilie* in 2012 and 2015.

Promotion of junior researchers

Junior researchers find ideal working conditions at INM and are supported on their career path by appropriate measures. As stipulated at the last evaluation, the number of doctoral candidates employed at INM has increased: due, in particular, to the number of joint appointments (see Chapter 4) which have been made since 2015, the figures have grown from 25 to 42 (as of 31 December 2016). It is welcomed that the average length of doctoral studies has been reduced, as recommended, from 4.5 to 3.9 years. Against this backdrop, it is expected that that the number of doctorates completed annually will increase, especially as between 2014 and 2016, only 14 students completed their doctorates. INM offers its doctoral candidates appropriate professional development opportunities. They are also eligible to take part in the graduate programme offered by Saarland University.

The approx. 40 postdocs also benefit from the excellent working conditions at INM. Apart from their own research work, they are involved in supervising doctoral candidates. Young group leaders particularly benefit from the flat hierarchy in which they can freely develop their own scientific profiles. The success of this approach is illustrated, amongst others, by the fact that three group leaders were offered professorships.

Vocational training for non-academic staff

INM actively promotes the training and continuing education of its non-scientific staff.

Between 2014 and 2016, five traineeships were successfully completed. There are currently six trainees at INM. The institute offers traineeships for chemical laboratory assistants, industrial mechanics, electricians, IT specialists and industrial management assistants.

6. Quality assurance

Internal quality management

INM uses appropriate tools and measures to assure quality. The performance of the groups is reviewed annually at meetings between the Board of Directors and the group leaders. All publications, patent applications and project proposals are reviewed and approved by the Board of Directors prior to submission. It is welcomed that all outgoing manuscripts are inspected for patentable ideas. At weekly meetings, the group leaders discuss new project ideas, funding calls and pending proposals. INM has an ombudsperson for good scientific practice.

As recommended at the last evaluation, INM has introduced a performance-based allocation of research funds (*Leistungsorientierte Mittelvergabe*, LOM), which has been very well received. In 2016, a total of €630k was distributed on this basis. As planned, INM should continue to develop the tool. The institute is also recommended to increase the proportion of the budget that is allocated to LOM distribution. Moreover, it should examine whether cooperation between INM groups could count as an award criterion (see recommendation in Chapter 2).

The administration, which has been under the leadership of INM's Business Director since 2014, is efficient. As stipulated at the last evaluation, administrative activities are determined by INM's scientific objectives, which they serve to fulfil.

Quality management by the Scientific Advisory Board

The Scientific Advisory Board (SAB) carries out its duties appropriately. It is welcomed that the standard audit, which Leibniz institutes conduct between evaluations, was held in 2014. In the past, the SAB has met twice a year. In order to reduce the burden on the Board members, it should be considered whether an annual meeting would suffice, as is the case at other Leibniz institutes.

Implementation of recommendations from the last external evaluation

To a very large extent, INM has convincingly implemented the 13 central recommendations issued by the Leibniz Association Senate in 2010 (see Status Report, p. A-23 ff.). Further action is only required in relation to the following three recommendations (in italics):

1. *Interdisciplinary cooperation between Research Fields and groups should be further strengthened over the next years.*

INM has made significant progress on this point, should, however, perpetuate the trend (see recommendation in Chapter 2).

2. *As has been envisaged by the institute, the vacant group leader position in the Program Division Modelling/Simulation should be filled as soon as possible.*

INM regularly carries out work in the field of modelling and simulation that is of importance to the institute with international partners. This is the appropriate solution INM found to not being able to fill the vacant group leader position in the Programme Division "Modelling/Simulation" as recommended at the last evaluation. In the mid-term, INM should keep trying to establish a position of this kind at the institute on a permanent basis (see Chapter 4).

3. *INM should make further efforts to increase the number of female scientists in leading positions.*

INM has appointed two female scientists to leading positions: the new second Scientific Director and the head of a Junior Research Group. Thus currently, three of the eleven group leaders are women. INM should continue to pursue this policy and keep increasing the proportion of women at group leadership level.

Appendix

Chair (Member of the Leibniz Senate Evaluation Committee)

Roland **Sauerbrey**	Helmholtz-Zentrum Dresden-Rossendorf

Deputy Chair (Member of the Leibniz Senate Evaluation Committee)

Ursula **Gaedke**	University of Potsdam, Dept. Ecology and Ecosystem Modelling

Reviewers

Helmut **Dosch**	Deutsches Elektronen-Synchrotron DESY, Hamburg
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Martina **Stenzel**	School of Chemistry, University of New South Wales Australia, Sydney
Markus **Winterer**	Nanoparticle Process Technology, Faculty of Engineering, University of Duisburg-Essen

Representative of the Federal Government

absent with apologies

Representative of the Länder *Governments*

absent with apologies

2. Guests

Representative of the relevant Federal government department

Peter **Schroth**	Federal Ministry of Education and Research, Bonn

Representative of the relevant Land *government department*

Susanne **Reichrath**	State Chancellery of Saarland

Representative of the Scientific Advisory Board

Gerhard **Langstein**	Covestro Deutschland AG, Leverkusen

Representative of the Leibniz Association

Thomas **Elsässer**	Max Born Institute for Nonlinear Optics and Short Pulse Spectroscopy in the Forschungsverbund Berlin e. V.

3. Representatives of collaborative partners (one-hour interview)

Manfred **Schmitt**	President of Saarland University
Frank **Mücklich**	Chair for Functional Materials at Saarland University
Andreas **Fery**	Institute for Physical Chemistry and Physics of Polymers, Leibniz Institute of Polymer Research Dresden
anonymous	Representative from industry

1 December 2017

Annex C: Statement of the Institution on the Evaluation Report

INM – Leibniz Institute for New Materials, Saarbrücken

The INM – Leibniz Institute for New Materials expresses its gratitude to all members of the review committee for their effective and fair evaluation of INM. We also thank the Leibniz Association for its efforts and assistance in the evaluation process. INM is very pleased about the favorable report attesting the remarkable reform and positive development of the institute, making it one of the world's leading institutes for material sciences.

INM appreciates the insightful recommendations put forward by the review committee. In particular, we would like to comment on the following:

- *Future perspectives*: INM will act on the express endorsement to emphasize the fields of "Biomedical Materials" and "Materials in the Digital Environment". These new perspectives hinge on the extension of infrastructure and space, as detailed in INM's report, and their successful realization requires the proposed temporary extraordinary item of expenditure.
- *Industrial funding*: We welcome the recommendation to alleviate constraints due to the currently imposed industrial targets, which are often incompatible with the primacy of scientific quality. This recommendation underlines the necessity to discuss revised strategies for third-party funding with the Scientific Advisory Board and Board of Trustees, with special emphasis on the scientific context.
- *Personnel development*: The introduction of an annual performance review for INM coworkers, as recommended in the report, has already been initiated and will be the subject of an upcoming training workshop for the group leaders.
- *Equal opportunities*: Equal opportunities as well as a good work-life balance for its employees will remain essential concerns for INM. The institute has already achieved a significant standing in this respect and will continue its efforts to further increase the proportion of women, especially at the level of group leaders.

We express our gratitude to all those who supported the institute on its successful path. This includes specifically the members of the Scientific Advisory Board and of the Board of Trustees. Overall, the evaluation report encourages us to continue on our fruitful path and is an excellent basis for the future development in its role as a leading member of the Leibniz Association.