Leibniz-Gemeinschaft

Der Senat

23. März 2015

Stellungnahme zum Leibniz-Institut für Festkörper- und Werkstoffforschung Dresden e.V. (IFW)

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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 8. und 9. Juli 2014 das Leibniz-Institut für Festkörper- und Werkstoffforschung Dresden (IFW). Ihr stand eine vom IFW 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 IFW nahm dazu Stellung (Anlage C). Der Senat der Leibniz-Gemeinschaft verabschiedete am 23. März 2015 auf dieser Grundlage die vorliegende Stellungnahme. Der Senat dankt den Mitgliedern der Bewertungsgruppe und des Senatsausschusses Evaluierung (SAE) für ihre Arbeit.

1. Beurteilung und Empfehlungen

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

Die **Aufgabe** des IFW ist Grundlagenforschung und anwendungsorientierte Forschung auf dem Gebiet der Material- und Werkstoffwissenschaften. Das Institut bedient sich dabei in einem ausgewogenen Verhältnis theoretischer und experimenteller Ansätze zum Verständnis der elektronischen Struktur von Quanten- und nanoskaligen Materialien. Ziel ist es u. a. neue Anwendungen hervorzubringen, die auf diesen funktionalen Materialien, erforschten physikalischen Effekten und neuentwickelten Bauelementen beruhen. Diese Mission erfüllt das IFW äußerst erfolgreich und hat sich dadurch die Stellung eines weltweit anerkannten Forschungsinstituts erarbeitet.

Mit einer institutionellen Förderung von über 29 Millionen Euro jährlich und über 500 Beschäftigten und Stipendiaten gehört das Institut zu den größten Einrichtungen in der Leibniz-Gemeinschaft. Das IFW besteht aus fünf Teilinstituten, die jeweils von einem gemeinsam mit einer Hochschule berufenen Direktor geleitet werden. Institutsübergreifend werden die **wissenschaftlichen Arbeiten** in derzeit fünf Forschungsschwerpunkten mit 13 Teilbereichen durchgeführt, die überwiegend als „sehr gut bis exzellent“ bewertet werden (zwei Bereiche „exzellent“, acht „sehr gut bis exzellent“, je ein Bereich „sehr gut“, „gut bis sehr gut“ und „gut“). Die ausgezeichneten Forschungsergebnisse werden hoch-

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

rangig publiziert und international stark wahrgenommen. Die Zusammenführung von Festkörperphysik und Materialwissenschaften ist eine besondere Stärke des IFW, die auch weiterhin erhalten bleiben soll.

Die **Drittmitteleinnahmen** des IFW sind insgesamt sehr hoch. Sie haben sich in den letzten Jahren kontinuierlich gesteigert und belaufen sich nun auf jährlich fast 10 Millionen Euro. Den größten Anteil machen dabei mit 5,5 Millionen Euro Mittel der DFG aus. Auch auf europäischer Ebene ist das Institut äußerst erfolgreich. So warb z. B. einer der Institutsdirektoren einen *ERC Advanced Grant* ein. Außerdem erhielten zwei Mitarbeiter *ERC starting grants*. Die Zusammenarbeit mit Unternehmen ist vielseitig und erfolgreich. Sie sollte jedoch über die Aktivitäten der Teilinstitute hinaus strategischer mit Blick auf das Gesamtkonzept des Instituts angelegt werden. Dies sollte auch dazu beitragen, die Drittmittel aus der Industrie zu erhöhen.

Das IFW kooperiert intensiv mit den **Universitäten** in Dresden und Chemnitz. Dies umfasst die gemeinsame Berufung aller fünf IFW-Direktoren, die gemeinsame Nutzung von Forschungsinfrastrukturen sowie die Zusammenarbeit in der Graduiertenförderung. Das Institut ist außerdem intensiv beteiligt an Sonderforschungsbereichen sowie an Maßnahmen, die über die Exzellenzinitiative von Bund und Ländern in Dresden gefördert werden (Exzellenzcluster, Zukunftskonzept der TU Dresden). Auch innerhalb der Leibniz-Gemeinschaft, mit anderen außeruniversitären Instituten in Sachsen sowie auf nationaler und internationaler Ebene ist das IFW ausgezeichnet vernetzt.

Das IFW hat eine angemessene Anzahl an Doktorandinnen und Doktoranden. Es ist erfreulich, dass einige der Promotionsstellen von Industriepartnern gefördert werden. Die Promovierenden werden sehr gut betreut. Für einige stehen strukturierte Programme zur Verfügung. Ziel sollte es nun sein, allen die Teilnahme zu ermöglichen, auch mit Blick auf die notwendige Verkürzung der Promotionsdauer. Das IFW bietet auch für den promovierten **wissenschaftlichen Nachwuchs** ein attraktives Arbeitsumfeld. So sind am Institut drei Emmy Noether-Nachwuchsgruppen beheimatet. Unbefriedigend ist, dass am IFW vergleichsweise wenige **Wissenschaftlerinnen** arbeiten. Das Institut muss den Anteil von Frauen auf allen Ebenen deutlich erhöhen.

Vor dem Hintergrund personeller Änderungen auf der Leitungsebene und der wissenschaftlichen Entwicklung auf dem Gebiet der Festkörper- und Werkstoffforschung plant das IFW, sein **Forschungsprogramm** neu zu strukturieren. Die vorgestellten Ansätze für die Weiterentwicklung besitzen ein hohes Potenzial, konnten aber nicht umgesetzt werden.

Im Zuge der Ausgestaltung und Umsetzung traten gravierende Meinungsverschiedenheiten zwischen den Institutsdirektoren zutage. Es gelang nicht, diese Konflikte intern zu bewältigen. Das Institut geriet in eine **Führungskrise**, die zum Rücktritt des amtierenden IFW-Direktors führte. Das Kuratorium hat zügig auf die Verwerfungen innerhalb der Leitungsebene reagiert. Unterstützt vom Beirat und weiteren Sachverständigen entschied das Kuratorium, die Position des IFW-Direktors mit einer erfahrenen wissenschaftlichen Führungspersönlichkeit zu besetzen, die nicht wie bisher üblich aus dem Kreis der fünf Institutsdirektoren stammt, sondern extern berufen wurde. Der neue wissenschaftliche Direktor des IFW übernahm kurz vor dem Besuch der Bewertungsgruppe seine Aufgabe. Er steht für eine begrenzte Zeit zur Verfügung. Der Senat begrüßt seinen Einsatz und ebenso, dass auch das erfahrene Administrative Vorstandsmitglied des IFW bereit war, über die Ruhestandsgrenze hinaus zunächst weiter am IFW tätig zu bleiben.

Unter der Leitung des jetzigen Vorstands muss nun zügig entschieden werden, welche **Reformen und Veränderungen** notwendig sind. Ziel muss es vor allem sein, die Strukturen am Institut so zu gestalten, dass ein übergreifendes Forschungsprogramm umgesetzt werden kann und so die hohe wissenschaftliche Leistungsfähigkeit der Leibniz-Einrichtung erhalten bleibt. Der Senat erwartet, dass alle Institutsdirektoren an diesem Prozess konstruktiv mitwirken. Er geht davon aus, dass Beirat und Kuratorium die Entwicklung des IFW weiterhin engagiert begleiten. Der Senat bittet den Vorstand des IFW, zum 31. Dezember 2015 über die strategische Entwicklung des Instituts, die zukünftige Struktur der Institutsleitung, das neue Forschungsprogramm und dessen Implementierung zu berichten.

Das IFW ist ein weltweit anerkanntes Institut auf dem Gebiet der Festkörper- und Werkstoffforschung und erzielt wissenschaftliche Spitzenleistungen. Dabei spannt das Institut den Bogen von der Grundlagenforschung bis hin zu Anwendungen. Die Erfüllung der Aufgaben ist in dieser Form an einer Hochschule nicht möglich. Eine Eingliederung des IFW in eine Hochschule wird daher nicht empfohlen. Das Institut erfüllt die Anforderungen, die an eine Einrichtung von überregionaler Bedeutung und gesamtstaatlichem wissenschaftspolitischem Interesse zu stellen sind.

2. Zur Stellungnahme des IFW

Der Senat begrüßt, dass das IFW 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 IFW als Einrichtung der Forschung und der wissenschaftlichen Infrastruktur auf der Grundlage der Ausführungsvereinbarung WGL weiter zu fördern.

23 June 2014

Annex A: Status Report

Leibniz Institute for Solid State and Materials Research (IFW) Dresden

Contents

1. Structure, Tasks and Institutional Environment

Development and funding

The Leibniz Institute for Solid State and Materials Research Dresden e. V. (IFW) was founded in 1992. It receives joint public funding by the Federal and *Länder* Goverments. The institute conducts research in the field of materials science based on solid state physics, materials engineering, electrical engineering, and chemistry. IFW was evaluated by the German Council of Science and Humanities (*Wissenschaftsrat*) in 1999 and by the Senate of the Leibniz Association in 2007.

Responsible department at *Länder* level: Saxon State Ministry for Science and the Arts (SMWK)

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

Mission and tasks

IFW's mission is to pursue fundamental research as well as application-oriented research and development, mainly in the field of solid state matter and materials science. Key elements of the research activities are both experimental and theoretical studies of the electronic structure of quantum and nanoscale materials and the characterisation of their physical and chemical properties. This includes the development of new applications based on these functional materials, on the investigated physical effects and on newly created devices.

Research structure

IFW is organised into five IFW institutes, each headed by an institute director. These five institutes are:

- Institute for Metallic Materials,
- Institute for Solid State Research,
- Institute for Complex Materials,
- Institute for Integrative Nanosciences,
- Institute for Theoretical Solid State Physics.

Each IFW institute itself consists of scientific departments and independent young research groups.

IFW's research programme has five research areas that are formed by contributions of more than one institute. Each research area is subdivided into topical areas. Additionally, IFW has an internal service unit "Research Technology Division" which builds and adapts research equipment for the specific needs of IFW's scientists. The five research areas and their 13 subdivisions are (see Chapter 3 for details):

(1) Superconductivity and Superconducting Materials

This research area deals with physical and chemical basics of superconductivity up to and including the development of materials for electro-technical applications.

- Subdivision 1 " Superconductivity and superconductors: Electronic structure and fundamentals"
- Subdivision 2 "Superconductivity and superconductors: Materials and applications"

(2) Magnetism and Magnetic Materials

Magnetism is the largest research area at IFW Dresden. Activities span from basic investigations of solid magnetic matter to the development of materials for new applications.

- Subdivision 3 "Magnetism and magnetic materials: Theoretical fundamentals"
- Subdivision 4 "Magnetism and magnetic materials: Experimental fundamentals"
- Subdivision 5 "Magnetic materials"
- Subdivision 6 "Magnetics and magnetic materials: Magnetic microstructures "

(3) Molecular Nanostructures and Molecular Solids

This research area deals with synthesis, doping, functionalisation as well as spectroscopic and transport investigations of conjugated carbon systems like fullerenes, carbon nanotubes and graphene.

- Subdivision 7 "Carbon nanostructures, conducting polymers, molecular magnets"

(4) Metastable Alloys

The focus of this research area is on nanoscale materials, amorphous metals and metastable intermetallic phases, prepared under non-equilibrium conditions (casting, rapid quenching and mechanical alloying).

- Subdivision 8 "Bulk amorphous metals, solidification and crystallisation"
- Subdivision 9 "Corrosion, electrochemical processing and hydrogen"
- Subdivision 10 "Electrochemical energy storage systems / Li-ion batteries"

(5) Stress Driven Architectures and Phenomena

This research area deals with micro-/nanostructures driven by stress relaxation in ultra-thin films as well as phenomena and applications based on stress generation on surfaces and in materials.

- Subdivision 11 "3D micro/nano architectures"
- Subdivision 12 "Quantum dots"
- Subdivision 13 "SAW systems"

Legal form and organisation

IFW is a registered association. It is represented in all matters by the Executive Board (see below). As an association IFW Dresden e. V. has, at present, nine members entitled to vote. These are the State of Saxony as a juridical person, the Scientific Director (who is one of the directors of the IFW institutes), the Administrative Director, the other four directors of the IFW institutes, one faculty member of TU Chemnitz and one faculty member of TU Dresden. Additionally, there are 21 members not entitled to vote.

The General Meeting decides and adopts changes of the institute's Statutes. Furthermore, it elects a member to the Board of Trustees from among its members, a further expert member to the Board of Trustees on the basis of a list of three presented by the Executive Board, and an auditor to verify the annual financial statements.

The Executive Board of IFW consists of two members, the Scientific Director who is the spokesperson of the Association, and the Administrative Director. Both directors are appointed by the Board of Trustees for five years, re-appointment is possible.

The supervisory body of IFW is the Board of Trustees. It consists of eight members, three each of the State of Saxony and the federal government as funding institutions, and two appointed by the General Meeting. The Board of Trustees decides on all fundamental matters of the Association. Duties include decisions on the research programme and its cost estimate, the appointment of members of the Executive Board, and the authorisation of members of the Scientific Advisory Board.

The Scientific Advisory Board (SAB) advises the Executive Board and the Board of Trustees in fundamental aspects of the scientific work programme, including the resources and investment planning, and consults on the recruitment of the institute's directors. The SAB meets at least once per year. It is composed of six to ten scientists who are closely linked to the areas of activity of the institute. Members are appointed for three years with consecutive reappointments being possible.

See Appendix 1 for an organisational chart.

National and international scientific environment

Materials science is an actively pursued field of research worldwide. All major industrialised countries maintain and support materials science institutions. IFW is devoted to materials research combining fundamental research in natural sciences with the development of new materials and devices.

On the national level there are institutions with partial scientific overlap or with complementary activities. These include, for instance, Peter Grünberg Institute at Helmholtz-Zentrum Jülich, Max Planck Institute for Solid State Research Stuttgart, Max Planck Institute for Intelligent Systems Stuttgart, Max Planck Institute for Microstructure Physics, Halle/Saale, NanoMicro Center at Karlsruhe Institute of Technology, and Helmholtz-Zentrum Dresden-Rossendorf. According to IFW, none of these institutions covers the range of IFW's research fields with a similar degree of interdisciplinary interconnections.

On the international scale, there are institutions with comparable research activities: the Paul Scherrer Institute Villigen, Switzerland, and Le Polygone CNRS de Grenoble, France, are national laboratories that operate on a significantly larger financial basis and are based on large-scale facilities. The Institute of Materials Research, Tohoku University, Sendai, Japan, and Ames Laboratory, Iowa State University, USA, have a budget comparable to IFW. The Canadian Institute for Advanced Research CIFAR, Canada, is supporting an international research programme on Quantum Materials, directed mostly towards superconductivity and magnetism. RIKEN Institute of Physical and Chemical Research, Japan, is much larger than IFW (seven campuses across Japan), but similar to IFW. It connects quantum science and emergent phenomena in many-body systems with applications of correlated materials in future electronic devices.

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

According to IFW, the supra-regional significance of the institute is manifested in its scientific excellence and competitiveness, its international visibility and acknowledgement of its research activities, its involvement into the international scientific community as a central member of collaborative networks and its high level of third party funding from competitive sources.

IFW states that its mission requires both an interdisciplinary approach and a distinct research focus, connecting the fields of experimental and theoretical condensed matter physics, electrical engineering, materials engineering and solid state chemistry. Its mission further necessitates a critical mass in each of the mentioned fields as well as an intensive collaboration and mutual stimulation between the respective areas of expertise. This includes the establishment, maintenance and constant modernisation of technological and knowledge infrastructure which cannot be provided by a university.

2. General concept and profile

Development of the institution since the last evaluation

The research activities of IFW Dresden are in the field of materials science and engineering ranging from basic research to applications. A key feature is the combination of materials science, solid state physics, chemistry and electrical engineering. While being distinctly multidisciplinary, IFW states that the common aspect of all activities is the investigation of yet unexplored properties of novel materials with the aim to establish new functionalities and applications.

IFW's five research areas were established in 1999 and have been gradually adapted since then. In the past years, for instance, new classes of materials came into the fore, in particular novel iron-pnictide superconductors, magnetocaloric devices, multi-ferroic materials, Heusler compounds, low-dimensional materials, bulk metallic glasses. Further developments and shifts of emphasis of the research structure were initiated by the appointment of two new institute directors. In March 2007, shortly before the last evaluation, the Institute of Integrative Nanosciences was founded. The newly hired director strongly influenced research area 5 "Stress Driven Architectures and Phenomena". In October 2009, the former director for the Institute of Theoretical Solid State Physics retired and a new director was appointed. He brought in new topics, especially in research areas 1 "Superconductivity" and 2 "Magnetism".

Strategic work planning for the next few years

Since the establishment of the five current research areas of IFW in 1999, four new directors of IFW institutes have been appointed. In 2014, the director of the Institute of Metallic Materials will retire and a further new director will be appointed. These changes on the level of the executive scientific staff and scientific progress in the fields of solid state and materials research motivated IFW to re-define its research strategy and to significantly restructure its research programme. The aim is to create additional synergy by strengthening interdisciplinary collaboration in house. The process has been supported by the Scientific Advisory Board and the Board of Trustees.

For the upcoming research programme, the three material classes Quantum Materials, Functional Materials, and Nanoscale Materials will serve as pillars that will encompass four new research areas (*Forschungsgebiete*, FG). Three of these FG will be each connecting two pillars. These FG will be "FG1: Functional quantum materials", "FG2: Function through size", and "FG3: Quantum effects at the nanoscale". The fourth area "FG4: Towards products" will intertwine all pillars. The idea is to enclose research projects that are close to prototypes and products. All in all, in the four research areas FG1-4, 19 research topics will be defined that will have finite time frames.

<u>FG1: Functional quantum materials</u>

FG1 is divided into five research topics all dealing with different aspects of bulk materials with a potential functionality due to novel, unconventional electronic properties. These projects include the continuation of IFW's work on superconductors and bulk magnetic materials.

Exotic ground states and low-energy excitations in bulk systems: The aim is to get insight into the magnetism of correlated quantum matter in a broad class of materials such as cuprates, cobaltites, and iridates. These materials will be synthesised and explored both experimentally and theoretically.

Unconventional superconductivity: Mechanisms, materials & applications: This project will utilize systematic studies on superconducting materials in order to advance the knowledge at the microscopic level, and to improve relevant parameters for the application of these materials.

Magnetic materials for energy: The properties and functionalities of magnetic materials are governed by intrinsic properties, extrinsic contributions and dimensionality. The focus will be on understanding and controlling these contributions in order to tailor materials for energy relevant applications.

Engineering magnetic microtextures: The aim is to fabricate non-collinear ferromagnetic states on mesoscales (up to several micrometres) that are stable at room temperature. Such microtextures are considered as promising objects for future applications in magnetic storage devices and spintronics.

Topological states of matter: Research will be focused on finding new topological insulators (TIs) and on investigating their protected surface states and transport properties by combining theory, synthesis and experiment.

FG2: Function through size

FG2 contains five projects. Two of them will consider materials with mechanical properties arising from structural arrangements at nanoscale. The other three will investigate basics and the application potential of inorganic nanomembranes and nanomagnets.

Non-equilibrium phases and materials: Research goal is the development of new materials from non-equilibrium states with at least parts of the microstructure remaining in non-equilibrium condition.

Intelligent hybrid structures: Activities will deal with the application of new routes for designing tailored metallic materials. These routes are based on scale-bridging hybrid-structures and enable property as well as functional optimisation.

Multifunctional inorganic nanomembranes: Research will deal with nanomembranes and rolled-up nanomembranes and their application potential for magnetoelectronics, lab-in-a-tube systems, compact on-chip energy storage elements and bio-microrobotic devices.

Nanoscale magnets: Nanomagnets ranging from intermetallic or half-metallic nanoparticles to Heusler compound nanowires will be designed, prepared, and characterised. Controlling the properties of nanoscale magnets through the chemical environment will be the main focus.

Materials for energy efficiency, storage & conversion: The aim is a concerted research activity in the fields of energy conversion/storage/efficiency. This will include the development and characterisation of materials for Li and Na batteries and capacitors as well as hydrogen production, storage and (re)-conversion to electricity for applications on different length scales.

FG3: Quantum effects at the nanoscale

The common topic of the four projects of FG3 is the development of new concepts and ideas for electronic or photonic devices. With FG3 IFW will move into a research direction which at present is not as established as the other research areas at IFW.

Designed interfaces and heterostructures: Interfaces will be synthesised, experimentally investigated and theoretically described. Systems that are envisaged will include transition metal oxides, elemental superconductors and ferromagnets as well as metal/electrolyte interfaces.

Self-organised electronic order at the nanoscale: It is planned to combine materials preparation, nano-structuring, spectroscopic studies, and theoretical modelling to investigate electronic self-organisation on the nanoscale and on various time scales.

Quantum and nano-photonics: Work will address fundamental topics (generation of single photons and entangled photon pairs, strong light-matter interactions in the quantum regime) as well as applications of these by fabrication of advanced photonic devices.

Functional molecular nanostructures and interfaces: It is planned to investigate selected kinds of probes like fullerenes, phthalocyanines, and further organic semiconductors using spectro-electrochemistry, scanning tunnelling, photoelectron, and electron-energy loss spectroscopies as well as density functional calculations.

FG4: Towards products

At present there are five topics relevant for a targeted application oriented research.

Surface acoustic waves: Concepts, materials & applications: Activities on surface acoustic wave (SAW) technology will be extended towards advanced materials and technologies for high-performance microacoustic devices including sensors and actuators operating under harsh conditions or fluidic environments.

Materials for biomedical applications: The vision is to tailor bio-solid interfaces for diagnostic biosensors and for therapeutic approaches with the aim for autonomous healing, and targeted drug and cell delivery. A further focus is the development of Titan based alloys and surfaces for implants.

High strength materials / Leibniz Application Laboratory Amorphous Metals: The Leibniz application laboratory Amorphous Metals will offer materials with high potential for industrial applications, especially with focus on high strength, high hardness, and high wear resistance. The idea is to transfer sophisticated technologies and materials towards industry.

FlexMag: Development centre for flexible magnetoelectronic devices: The aim of FlexMag is to develop flexible, stretchable and printable magnetic sensorics towards industry-ready products.

Concepts and materials for superconducting applications: The aim is to develop and investigate superconducting materials and demonstrator systems that enable the realisation of applications in power, magnet and transport technology.

Results

IFW's priorities are the publication of scientific results in peer-reviewed journals and research of new material developments that result in innovations. In the period 2011-2013, a total of 1,262 scientific papers appeared in international peer-reviewed journals. Additionally, 73 individual contributions to edited volumes, 5 edited volumes with editorship and 1 monograph were published (*cf.* Appendix 2). Some examples of IFW's research highlights in the reporting period are given in Section 3.

Services and commissioned work are not the main focus of IFW. Nonetheless, in the years 2011-2013, revenues from services totalled 1.9 M€.

Members of the scientific staff of IFW Dresden participate in evaluation panels for funding organisations like DFG or the EU FP7 programme. They also serve in Scientific Advisory Boards of other institutions in Germany (e.g. Max-Planck-Institute for Solid State Research Stuttgart, Helmholtz-Zentrum Berlin, DLR Institute of Materials Physics for Space) and abroad (e.g. Department of Materials at ETH Zürich, Basque Centre for Materials Bilbao, Instituto de magnetism applicado Madrid, Max-Planck-Indian Partner Group "Electronic structure of low dimensional and nano-scale systems").

IFW strives to obtain protection for its intellectual property/creative work via patent application. In the years 2011-2013, a total of 31 patents were granted, additional 78 were registered. In the same period, revenues from exploitation of intellectual property summed up to 102 k€. In order to draw attention to patens and competences, IFW attends trade shows and works with commercialisation agencies.

Since 2008 two companies were founded: in 2009, the company *Scientific Instruments Dresden GmbH, ScIDre,* as a spin-off from the Research Technology Department and in 2010 the company BeletroniG as a spin-off from scientific work.

Academic events and public relations

In recent years, members of IFW have organised two large international conferences: In 2012, the "IEEE International Ultrasonics Symposium2012" with 1,200 participants took place in Dresden. In 2014, the "IEEE Intermag Conference 2014" with about 1,500 participants was also held in Dresden. The annual "Spring Meeting of the Solid State Matter Section" of the German Physical Society (*DPG Frühjahrstagung der Sektion Kondensierte Materie*) alternately takes place in Berlin, Regensburg and Dresden. In 2011 the meeting in Dresden had about 7,000 participants. The local chair of this conference is one of the directors of the IFW institutes. In 2014, the meeting took place in Dresden for the sixth time.

The number of invited lectures held by the scientific staff of IFW at conferences and events amounts to 100 per year. Additionally, annually about 150 invited talks are given at seminars and colloquia at other institutions around the world.

With its public relations IFW aims at making scientific work accessible for the general public. The purpose of these activities is to inspire young people to study natural sciences or engineering, to convince the general public of the need and meaningfulness of public research funding, and to attract potential job applicants and partners in companies. The instruments that are used are press releases and media work, public events, guided laboratory tours, IFW's website, the newsletter "ifw intern", and printed materials like flyers or image brochures.

Appropriateness of facilities, equipment and staffing

The total revenue of IFW in 2013 was approximately 40.6 M€. Appendix 3 gives a detailed list of IFW's revenue and expenditures from 2011 to 2013.

In 2013, IFW's institutional funding, 50 % of which is provided by the Federation and 50 % by the *Länder,* was 29.3 M€.

The revenue from project funding grants increased within the last three years from 8.7 M€ (24 % of the total budget) in 2011 to 9.8 M€ (25 %) in 2013. During the last reporting period 2004-2006, the amount of revenues from project funding grants was 18 % on average. For the whole period from 2011 to 2013, third party funds add up to 27.6 M€. Of these, the share of revenues from project funding grants from the German Science Foundation (DFG) amounted to 13.6 M€, revenues from grants from the Federal and *Länder* governments amounted to 4.6 M€, and revenue from grants from the EU amounted to 2.7 M€. Revenues from grants from industry totalled 4.1 M€.

IFW is accommodated in a modern complex of buildings, consisting of a historical building (4,210 m^2), a large annex building from 1999 (9,752 m^2) and a further annex building with offices and labs inaugurated in February 2014 (718 m^2). Additionally, IFW rents a workshop of 1,168 m^2 for the test facility Supratrans II and 329 m^2 of laboratories at the campus of TU Chemnitz. According to IFW, the facilities offer a sufficient amount of space, both for offices and for laboratories. Concerning the infrastructure, the Scientific Advisory Board of IFW Dresden continuously stated that the technical infrastructure and research equipment is outstanding and highly competitive.

IFW considers its human resources as appropriate.

3. Subdivisions of IFW

Subdivision 1 "Superconductivity and Superconductors: Electronic Structure and Fundamentals" (13.26 FTE)

In this subdivision the electronic structure and underlying mechanisms of superconductivity and competing phases in a variety of superconductors and related materials are studied. The main motivation is the absence of a quantitative and comprehensive theory of superconductivity. Research activities include iron-based superconductors, cuprates, ruthenates, heavy fermion systems and elemental as well as other conventional superconductors.

134 articles in peer-reviewed journals were published in 2011-2013. In the same period, revenues from project grants from the German Science Foundation (DFG) totalled 1,897 k€ while 102 k€ were raised from industry. Research highlights included e.g. the study of the structure of the order parameter in LiFeAs using the quasiparticle interference (QPI) technique and the resolution of the so-called ARPES-QPI paradox for this material.

To further elucidate the knowledge of superconductivity at a microscopic level, IFW sees its contribution in providing systematic and quantitative information obtained by applying different and complementary experimental methods to essentially the same samples with a subsequent treatment by theoretical tools. Experimental tools will include momentum resolved spectroscopy and thermodynamic, transport as well as phase-sensitive techniques applied together to single-crystalline and in-situ grown thin film and heterostructured materials, such as iron-based pnictides and chalcogenides, cuprates, heavy fermion systems, ruthenates and elemental superconductors.

Subdivision 2 "Superconductivity and Superconductors: Materials and applications" (26.5 FTE)

The aim of this subdivision is to study and develop superconducting materials and demonstrator systems that enable the realisation of new applications in power and magnet technology. In terms of materials, the focus is on high-T_c cuprates, on MgB_2 and on iron-based superconductors.

In the reporting period, 76 articles in peer-reviewed journals and 1 individual contribution to an edited volume were published. In the same time, revenues from project grants from DFG totalled 241 k€ while 473 k€ came from EU grants. In addition, 213 k€ came from revenues from the Federal or *Länder* governments, 222 k€ from the competitive procedure of the Leibniz Association and 616 k€ from industry. Ten industrial property rights were granted to Subdivision 2 from 2011-2013. Revenues from the exploitation of intellectual property rights totalled 21 k€. Research highlights included thin film growth of iron-based superconductors, the development of YBCO coated conductors and the investigation of ac-losses in superconducting motors.

It is planned to continue the work within the research projects "Unconventional superconductivity: Mechanisms, materials & applications" and "Concepts and materials for superconducting applications" of the upcoming research programme (*cf.* Section 2). Specifically, topics that will be addressed within the next years are basic application relevant properties of cuprates and Fe-based superconductors, improved coated conductors, wires for high-field magnet applications, MgB_2 bulk materials for superconducting permanent magnets, and small- as well as large-scale levitation applications.

Subdivision 3 "Magnetism and magnetic materials: Theoretical fundamentals" (11.06 FTE)

In this subdivision, the theoretical fundamentals of magnetism and magnetic materials are studied in close relation to method development. Formerly, the main focus was on the Full Potential Local Orbital (FPLO) minimum basis code for solving the Khon-Sham equations on a regular lattice. In October 2009, the director of the institute of Theoretical Solid State Physics retired. With the new director the spectrum of theoretical approaches to quantum magnetism changed, in particular, into the area of model Hamiltonians for strongly correlated electron systems. An Emmy Noether-group was established in 2009. In this group, a range of numerical techniques are developed and applied to quantum many-body problems. Also, the theoretical area of Quantum Chemistry has been build up since then.

In the reporting period, 137 articles in peer-reviewed journals were published, 29 of them in collaboration with other subdivisions. In the same time span, revenues from project grants from DFG totalled 1,110 k€. 219 k€ came from revenues from the competitive procedure of the Leibniz Association and 33 k€ from industry. Most of the results were obtained by a number of different analytical and numerical methods ranging from algebraic formalisms via exact diagonalisation of model Hamiltonians, quantum chemical and density functional theory (DFT) approaches to analytical and numerical continuum theory (micromagnetism).

Future work planning will be focused on topics that have also been dealt with before. In particular, these topics include low-dimensional and frustrated magnetism, resonant inelastic X-ray spectroscopy, topological insulators, magnetic films and nanomagnets, skyrmions, chiral magnets, and multiferroicity, bulk magnets as well as functional magnetic nanomembranes.

<u>Subdivision 4 "Magnetism and magnetic materials: Experimental fundamentals"</u> (31.71 FTE)

This subdivision experimentally investigates materials in which strong electron-electron correlations and entanglement of spin, charge, orbital and lattice degrees of freedom give rise to novel quantum magnetic phases of matter and exotic excitations. The focus is on the understanding of fundamental physics of new magnetic phenomena occurring in these materials. Also, the potential of emerging material properties for technological applications is assessed, e.g., in novel electronic devices.

In 2009, the Marie-Curie Initial Training Network "Low-Dimensional Quantum Magnets for Thermal Management" (LOTHERM) was initiated. The project was coordinated by IFW Dresden and ended in September 2013. It comprised nine European full partners from academia and industry and two strategic industrial partners. In 2008, the Emmy Noether-research group "Synchrotron studies of quantum matter" was established at IFW. Since 2010, a second Emmy Noether-group "Optimisation of Heusler compounds for spintronics by control of the relation between structure and properties" is affiliated to this subdivision. Members of this subsection also participate in the DFG research unit "Coherence and relaxation of electron spins".

In the period 2011-2013, 88 articles in peer-reviewed journals and 2 individual contributions to edited volumes were published. 25 of these publications resulted from collaborations with other subdivisions. In the same period, revenues from project grants from DFG totalled 2,435 k€ while 442 k€ came from EU grants. Additionally, 350 k€ came from grants from the Federal or *Länder* governments. 198 k€ came from revenues from the competitive procedure of the Leibniz Association and 493 k€ from industry grants. One of the core areas of research was the investigation of quantum ground states and elementary excitations in insulating cuprates.

Subject of future research will be the exploration of new magnetic effects in materials, in which new fundamental phenomena driven by strong relativistic spin orbit coupling were discovered, such as novel Mott-insulating phases in oxides and topologically non-trivial phases in semiconductors. A new focus will be on magnetic phenomena arising at the interface between non-magnetic insulators, insulators and metals, or at nanoscale surfaces that can be controlled and tuned at will, e.g., by electrical gating. A new focus of future research will also be on the exploration of new functionalities of low-dimensional oxides and intermetallic compounds with regard to magnetocaloric and thermoelectric effects.

<u>Subdivision 5 "Magnetic materials"</u> (20.65 FTE)

The research of this subdivision on magnetic materials covers nanoparticles, nanowires, thin films as well as bulk materials and their composites. The overarching motivation is the production of environmentally friendly and sustainable magnetic materials as well as the development of next generation magnetic materials and devices with enhanced properties.

In the reporting period, 104 articles in peer-reviewed journals were published. Thereof, 13 articles where published in collaboration with other subdivisions. In the same period, revenues from project grants from DFG totalled 1,567 k€. 656 k€ came from grants from the Federal or *Länder* governments, 123 k€ from EU grants, and 411 k€ from industry. In the reporting period, four industrial property rights were granted to this subdivision, generating revenues of 39 k€. Among the scientific highlights, e.g., is a research project on sintered Nd-Fe-B magnets which included the analysis of all phases in its microstructure using electron backscatter diffraction.

Work planning on bulk permanent magnets will include a continuation of the study and development of rare earth transition metal magnets like Nd-Fe-B as well as the development of novel rare-earth-free magnet systems within the new Research Focus "Magnetic materials for energy". Further future topics will include hard magnetic films and multilayers, magnetic nanoparticles, magnetic shape memory alloys, magnetic refrigeration, and magnetic materials and nanostructures by electrochemical routes.

Subdivision 6 "Magnetics and magnetic materials: Magnetic microstructures" (10.32 FTE)

The research of this subdivision on magnetic microstructures comprises theoretical and experimental analysis. Experimental techniques include magneto-optical Kerr microscopy and magnetic force microscopy. The magnetic materials that are investigated are, e.g., electrical steel, novel nanocrystalline ribbons, magnetic semiconductors, ferro- and antiferromagnetic layer systems with exchange bias as well as uniaxial and biaxial anisotropies, strongly coupled multilayers with perpendicular anisotropy, magnetic films with permanent magnetic, spin-caloric and magnetic shape memory properties, rolled-up magnetic films and nanostructures for current-induced domain wall propagation.

In the years 2011-2013, 33 articles in peer-reviewed journals were published. 11 of these publications resulted from collaborations with other subdivisions. In the same period, revenues from project grants from DFG totalled 195 k€ while 17 k€ came from grants from the Federal or *Länder* governments. Additionally, 137 k€ came from industry grants. Research highlights include, e.g., a project in which by manipulating magnetic domains of high-purity bulk iron single crystals resistivity changes up to a factor of 100 were measured. Another project developed a technique that lowers the minimum critical disk diameter for vortex formation, which enables an increase of the data storage density in devices based on magnetic vortices.

In the future, the analysis of conventional magnetic microstructures will be continued. The focus will still rest on a fundamental understanding of magnetic domains and micromagnetism of a variety of materials and systems. It is planned to establish a new research topic that aims at the fabrication of non-collinear ferromagnetic states on mesoscales (up to several micrometres) that will be stable at room temperature.

Subdivision 7 "Carbon nanostructures, conducting polymers, molecular magnets" (12.75 FTE)

Materials investigated by subdivision are classified as novel functional nanomaterials. They are composed of nanostructures solely based upon carbon (fullerenes, carbon nanotubes, graphene) as well as the combination of carbon-based nanostructures with other materials, and organic molecular semiconductors and molecular magnets. Characteristically, specific materials are identified, optimised and modified either addressing fundamental questions or meeting the requirements for different applications.

Within this subdivision the "Center of Spectroelectrochemistry" (CSE) was founded in December 2009. It supports research with regard to electron transfer and doping of organic semiconductors, conducting polymers, oligomers, fullerenes, organometallic compounds for in house activities and academic partners in Dresden. CSE is also active in applied research via joint projects with industry and hosts international schools on spectroelectrochemistry.

In the reporting period, 227 articles in peer-reviewed journals, 13 individual contributions to edited volumes, and 3 edited volumes (editorship) were published. In the same period, revenues from project grants from DFG totalled 1,783 k€. 497 k€ came from grants from the Federal or *Länder* governments, 276 k€ from industry grants and 155 k€ from foundations. In the reporting period, two industrial property rights were granted to Subdivision 7. Scientific highlights were, e.g., spectroscopic studies that demonstrated the growth of crystalline organic heterojunctions or investigations of a broad class of multicentre 3*d* transition metal complexes using high-frequency high magnetic field electron spin resonance instrumentation and static magnetometry methods.

In the future, research activities will be organised in terms of functionalities of materials under investigation. In particular, objectives for the next years are magnetism of functionalised molecular materials, exploration of Heusler compounds at the nanoscale, carbon nanotube-based magnetic nanoelectromechanical systems, novel type of magnetic heterointerfaces, new types of endohedral fullerenes, biocompatible surfaces of implants and microtubes.

Subdivision 8 "Bulk amorphous metals, solidification and crystallisation" (38.79 FTE)

This subdivision focuses on synthesis, structural analysis, and tailoring mechanical properties of advanced metastable metallic alloys. The materials under investigation are novel metallic glasses, nanostructured composites and nanoparticles. Research in the last years was focused on the design of heterogeneous metallic glasses. In order to prepare large-scale parts with complex structures for application, thermoplastic shaping and selected laser melting were introduced as new preparation routes.

In the reporting period, 211 articles in peer-reviewed journals and 17 individual contributions to edited volumes were published. In the same period, revenues from project grants from DFG totalled 1,185 k€ while 133 k€ came from EU grants. In addition, 498 k€ came from revenues from the Federal or *Länder* governments, 452 k€ from industry and 94 k€ from foundations and other sponsors. Revenues from commissioned work summed up to 82 k€. In the same period, six industrial property rights were granted to this subdivision. Revenues from the exploitation of intellectual property rights totalled 9.3 k€. Research highlights were the development of new bulk metallic glasses and glass matrix composites with high strength and enhanced ductility.

Research of this subdivision is considered to find continuation within the planned research projects “Non-equilibrium phases and materials”, the recently awarded 5-years ERC Advanced Grant “INTELHYB: Next generation of complex metallic materials in intelligent hybrid structures” as well as within the “Leibniz Application Laboratory for amorphous materials” (*cf.* Section 2).

<u>Subdivision 9 “Corrosion, Electrochemical processing and Hydrogen”</u> (19.52 FTE)

This subdivision investigates chemical properties of advanced metallic materials in dependence on their composition- and process-controlled microstructures and surface states with the aim to exploit their functionality. The focus is on corrosion phenomena. Research spans from fundamental analyses of corrosion mechanisms in defined media to solutions for application-specific questions. Scientists of this subdivision participate in the Collaborative Research Centre SFB/TRR 79 with the project “Ti-based alloys for biomedical applications” and in the DFG Priority Programme SPP 1594 with the project “Stress corrosion in bulk-glass forming alloys (BMGs)”.

In the reporting period, 65 articles in peer-reviewed journals and 2 individual contributions to edited volumes were published. In the same period, revenues from project grants from DFG totalled 1,119 k€ while 561 k€ came from EU grants. 98 k€ came from revenues from the competitive procedure of the Leibniz Association and 101 k€ from industry. Revenues from commissioned work and from the exploitation of intellectual property rights totalled 59 k€ and 9.3 k€, respectively. Among the scientific highlights was the development of an electrochemical micromachining technique (ECMM) for shaping bulk metallic glass surfaces.

The research activities of this subdivision will be implemented in various new research projects. E.g., activities on corrosion and electrochemical processing (micro-shaping) of BMGs and related composites will be incorporated into the projects “Intelligent hybrid structures” and “Leibniz application lab for amorphous materials”. Activities on new Ti-based alloys for biomedical applications will play a key role in the new project “Materials for Biomedical Applications”. Activities on corrosion of magnetic materials will be linked with the future topic “Magnetic materials for energy”. Planned activities on hydrogen storage materials will be implemented in the research project “Materials for energy efficiency, storage & conversion” (*cf.* Section 2).

<u>Subdivision 10 “Electrochemical energy storage systems / Li-ion batteries”</u> (15.33 FTE)

In this subdivision electrode materials are investigated with the aim to improve power and energy densities of electrochemical energy storage systems and to obtain information on mechanistic aspects of storage processes. Some topics of the work programme have changed successively from classical Li-ion type batteries with focus on crystallographic structure to property relationships to chemistry-based research in the area of sulphur-based lithium- and sodium-systems. In the time span 2010 – 2013, scientists of this subdivision participated in the DFG Priority Programme SPP 1473 as well as in further networks like the BMBF project “BamoSa” and the BMU project “Batterie – Stationär in Sachsen (BaSta)”.

In the years 2011-2013, 59 articles in peer-reviewed journals and 2 individual contributions to edited volumes were published. In the same period, revenues from project grants from DFG totalled 787 k€ while 504 k€ came from grants from the Federal or *Länder* governments. Additionally, 98 k€ came from revenues from the competitive procedure of the Leibniz Association and 488 k€ from industry grants. Revenues from commissioned work and from the exploitation of intellectual property rights totalled 1,557 k€ and 9.3 k€, respectively. Research highlights included, e.g., projects dealing with anode materials that are prepared as bulk alloys and via roll-up techniques. With amorphous alloys in the Li-Al system and rolled-up thin films consisting of Ge and Ti or Si and C layers, two basic preparation concepts were shown to overcome the breakdown of crystalline alloys after a few charging cycles.

The future work programme for electrochemical energy storage will cover electrode materials for smallest devices, as electrical energy source on a chip, small devices, for (electro) mobility, or large devices like grid buffers. Research will be continued in the new research topic “Energy efficiency, storage and conversion” (*cf.* Section 2).

Subdivision 11 “3D micro/nano architectures” (32.6 FTE)

The work of this subdivision explores the fundamental properties of rolled-up nanomembranes. The subdivision was established in March 2007, when the Institute of Integrative Nanoscience was founded at IFW Dresden. Scientists of this subsection participate in the DFG research groups 1154 “Towards Molecular Spintronics” and 1713 “Sensorische Mikro- und Nanosysteme”.

In the reporting period, 92 articles in peer-reviewed journals and 3 individual contributions to edited volumes were published. In the same period, revenues from project grants from DFG totalled 415 k€ while revenues from EU grants totalled 464 k€. In addition, revenues totalled 504 k€ from the Federal or *Länder* governments, 53 k€ from industry grants and 853 k€ from foundations. In the reporting period, one industrial property right was granted to this subdivision. Research highlights include first demonstrations of red light emitting vertical ring resonators, optofluidic microtube sensors, microjet engines and micro-biorobots, self-wound capacitors and batteries, as well as metamaterial optical fibres, ultra-compact giant magnetoresistive and lab-in-a-tube systems. Two scientists of this subdivision each received an ERC starting grant.

Future work planning mainly focuses on a continuation and further development of current research activities in rolled-up nanophotonics, magnetic and superconducting tubes, lab-in-a-tube, on- and off-chip energy storage, micromotors, flexible magnetoelectronics, and rolled-up spin wave resonators and metamaterials. Together with partners from TU Chemnitz and the Fraunhofer Institute for Electronic Nano Systems ENAS, a new research building entitled “Materials, Architectures and Integration of Nanomembranes (MAIN)” will be built, which is planned to be completed at the end of 2017.

Subdivision 12 "Quantum dots" (13.04 FTE)

This subdivision studies quantum dots (QD), which are made of either group III-V materials or group IV materials, with the aim to develop novel concepts for applications in quantum optical communication as well as in quantum computation. Research activities include epitaxial growth, photonics, quantum transport, thermoelectrics, quantum optics and novel optoelectronic devices. The subdivision was established in March 2007, when the Institute of Integrative Nanoscience was founded at IFW Dresden.

In the reporting period, 57 articles in peer-reviewed journals, 4 individual contributions to edited volumes, and 1 edited volume (editorship) were published. In the same period, revenues from project grants from DFG totalled 361 k€ while revenues from EU grants totalled 322 k€. 371 k€ came from grants from the Federal or *Länder* governments and 33 k€ from industry. Among research highlight is the growth of Ge nanowires with a height of 3 unit cells and a length of up to 2 micrometers by molecular beam epitaxy. Another project led to the demonstration of an all-electrically operated wavelength-tuneable single-photon source.

Future work planning is focused on the continuation and further development of current research activities in epitaxial growth, novel physics revealed by strain engineering, quantum light sources, and transport and thermoelectric properties.

Subdivision 13 "SAW systems" (6.52 FTE)

In the last years, the research focus of this subdivision has been on both, fundamentals and applications of SAW structures as well as on design, preparation and characterisation. Research was successively directed to new piezoelectric single crystals for unconventional SAW based sensors and actuators like members of oxoborate and langasite families. In December 2013, the "SAWLab Saxony – Competence Center for Acoustoelectronic Fundamentals, Technologies and Devices" was founded. It comprises the vision to focus interdisciplinary research activities and expertise of different departments of IFW and to combine them with the competence of other partners in Saxony.

In the years 2011-2013, 26 articles in peer-reviewed journals, 19 individual contributions to edited volumes, and 1 monograph were published. Five publications resulted from work in collaboration with other subdivisions. In the reporting period, revenues from project grants from DFG totalled 540 k€ while revenues from EU grants totalled 87 k€. 922 k€ came from grants from the Federal or *Länder* governments, 954 k€ from industry and 283 k€ from foundations. Revenues from commissioned work and from the exploitation of intellectual property rights totalled 32 k€ and 6.8 k€, respectively. In the reporting period, seven industrial property rights were granted to this subdivision. Scientific highlight were the development of experimental setups and different methods of analysis to study specific microacoustic aspects, e.g. the wavefields, the local temperature at the surface of SAW devices, or the power durability and lifetime of SAW devices.

Future investigation will include new SAW design principles, new generation of piezoelectric single crystals, creation processes of polar nanoregions and their interaction with magnetic sub-systems in relaxor ferroelectrics with magnetic ordering, SAW based fluid actuators, thin film materials for SAW applications, and dedicated analytical methods for thin films.

4. Collaboration and networking

Collaboration with universities

IFW is linked to TU Dresden by joint appointments of four directors of IFW institutes and to TU Chemnitz by the joint appointment of one IFW director. From 2011-2013 one scientist of IFW has been an adjunct professor (*Honorarprofessor*) at TU Dresden, one at TU Chemnitz and three at TU Bergakademie Freiberg. The Administrative director holds lectures as Honorary professor at TU Bratislava.

IFW is involved in two measures of the successful application of TU Dresden in the Excellence Initiative: the Institutional Strategy "The Synergetic University" and in the Cluster of Excellence "Center for Advancing Electronics Dresden (cfAED)." A further cooperation was established in 2013 with the formation of the "Centre for Transport and Device (CTD)" as a joint institution at faculty level at TU Dresden. One of the 14 subprojects of the "European Centre for Emerging Materials and Processes Dresden (ECEMP)" at TU Dresden, funded by the Free State of Saxony since 2007, is based at IFW.

IFW collaborates with TU Chemnitz in the "Center of Excellence for Nanosystem Integration". Together with TU Chemnitz and Fudan University Shangai, IFW fosters the International Research Training Group „Materials and Concepts for Advanced Interconnects and Nanosystems ". IFW is also involved in the Cluster of Excellence "Merge Technologies for Multifunctional Lightweight Structures - MERGE" of TU Chemnitz. The "Center for Materials, Architectures and Integration of Nano Membranes – MAIN" at TU Chemnitz is led by one of IFW's directors. In 2010, IFW has set-up a research site at the "Smart Systems Campus" of TU Chemnitz.

The academic staff of IFW participates in teaching at TU Dresden, TU Chemnitz, TU Bergakademie Freiberg, HTW Dresden, the Lausitz University of Applied Sciences, and the University of Vienna.

On the national level, IFW collaborates with groups from other German universities in approx. 150 projects funded by DFG, amongst others 12 Priority Programmes, 3 Collaborative Research Centres, and 5 Research Units.

Collaboration with other domestic and international institutions

IFW collaborates in national and international projects with other research institutions: In the years 2011-2013, IFW was involved in 22 EU-projects. Thereof 10 were coordinated by IFW. During the reporting period, IFW participated in 6 projects funded by BMBF.

IFW is part of the *Leibniz Nano-Network* which unites Leibniz institutions with expertise in Nano-Technology, of the Leibniz Research Alliance "Medical Technology: Diagnosis, Monitoring and Therapy" and of the *Leibniz Transfer Alliance Micro-Electronics* which connects current know-how, research and development efforts and existing infrastructures at various Leibniz institutions in the fields of Micro- and Opto-Electronics.

Other collaborations and networks

IFW participates in cooperation networks with small and medium-sized companies. These networks feature up to 68 industry partners, e.g., Toyota Europe, Bosch, Solarworld, BASF Future Business, EADS, and Siemens München.

During 2011 and 2013, a total of 441 scientists visited IFW for at least one week, 200 of them for longer than 3 months. In the same time span, 290 scientist of IFW visited other institutions for at least a week, 8 of them for longer than 3 month.

5. Staff development and promotion of junior researchers

Staff development and personnel structure

At the end of 2013 IFW employed 539 staff members, including 123 doctoral candidates and 22 trainees. Furthermore, in 2013, IFW hosted 69 fellowship holders who came with their own money. 15 diploma students worked at IFW and 34 trainees received practical training at the institute in 2013. 78.7 % of the staff belong to the five scientific IFW institutes, 7.8 % to the Research Technology Division, 6.5 % to administration, and 3 % to the Executive Board and Support Staff. The percentage of apprentices amounted to 4 % (for details see Appendix 4).

In April 2013, the director of the IFW Institute of Complex Materials was appointed the new Scientific Director and Speaker of IFW. He continues to be director of the Institute of Complex Materials. In March 2007, the Institute of Integrative Nanosciences was founded at IFW and a new director was appointed. In October 2009, there was a change on the leadership position of the Institute of Theoretical Solid State Physics after the former director retired.

The Director of the IFW Institute for Metallic Materials will retire in October 2014. The procedure for a new appointment is in progress. The current term of the Administrative Director ends on July 31, 2014. A search committee for a successor has already led job interviews.

Among senior staff positions there have been several changes. The head of the "Functional Composite Materials" department received an appointment to KIT Karlsruhe in December 2010. In June 2012, the head of the "Quantum Dots" department moved to a research institution in Linz, Austria. In October 2013, the head of the department "Superconducting Materials" received an appointment at KIT Karlsruhe. Another senior staff member received an appointment as a professor at Martin Luther University Halle-Wittenberg.

The head of the department "Chemical Vapour Deposition" will retire in July 2014 and the head of the "Structure Research" department at the end of January 2015.

Promotion of gender equality

IFW promotes gender equality on the basis of recommendations by DFG and the Leibniz Association. Since 2002, the institute has an equal opportunity commissioner and a corresponding deputy. The equal opportunity commissioner is spokesperson of the working group Gender Equality of the Leibniz Association.

At the end of 2013, there were no women among the five directors of the IFW institutes. 4 out of 13 scientific positions on an executive level were filled with women. In 2013, IFW defined flexible target figures for increasing the portion of women, and thus implemented the *Kaskadenmodell* which is obligatory for all Leibniz institutions.

In 2007, 2010 and 2013 IFW was certified by *berufundfamilie* gGmbH.

From January 2009 to December 2011, IFW coordinated the EU project "Improving the gender diversity management in materials research institutions". The project gathered 13 European partners and dealt with the topic of women being under-represented in senior positions at research institutions.

Promotion of junior researchers

In 2013, more than 140 PhD candidates were supervised at IFW. Most of them were employed at IFW, according to TV-L with ½ EG 13, approx. 15 % received scholarships. The majority of PhD candidates are enrolled at TU Dresden, increasingly also at TU Chemnitz. IFW belongs to the partners of the International Research Training Group (*Internationales Graduiertenkolleg* 1215) "Materials and Concepts for Advanced Interconnects and Nanosystems", jointly funded by DFG and the Chinese Ministry of Education. The average time for the completion of a PhD-thesis at IFW is currently 4.5 years. In 2011-2013, a total of 81 doctoral degrees have been completed.

PhD candidates who complete their thesis *summa cum laude* are awarded the Tschirnhaus Medal by IFW. In 2011 to 2013, the Medal has been awarded 14 times.

In 2007 to 2013, 18 IFW employees received appointments to university professorships.

Vocational training for non-academic staff

IFW constantly employs about 20 apprentices. The available professions are physics lab technician, chemistry lab technician, office management assistant, electronics technician, technical product drafter, industrial mechanic, and librarian. Within the last three years, 19 persons completed their training. Moreover, there have been two apprenticeship contracts with *Berufsakademie* students (BA, university of cooperative education).

Since 2006, every two years IFW holds a two-day technician school for the non-academic staff of the institute. The objective is to present questions, work methods and developments in various work fields, research specialities and administrative topics.

The Administrative Director of IFW is the representative for dual education and training in the Leibniz Association.

6. Quality assurance

Internal quality management

All members of IFW are obliged to act according to the binding guidelines for good scientific practice of IFW which follow the Recommendations of the German Science Foundation for Safeguarding Good Scientific Practice. An ombudsperson is elected every two years.

The annual research planning takes place during a three-day programme meeting involving about 70 responsible scientists. The annual research programme has to be confirmed by the Scientific Advisory Board and serves as a basis for the programme budget. Since 2003, IFW has a system of cost-performance assessment (*Kosten-Leistungs-Rechnung, KLR*). It comprises scientific output parameters like publication numbers, invited talks, external funds, and patents for each of the five research areas.

IFW has a scientific-technical council. In a monthly report it informs the Executive Board, the institute's directors and the heads of administration and Research Technology Division on quality parameters, like acquired third-party funding, publications and changes in personnel.

In 2013, IFW hired an internal auditor to fulfil an independent monitoring function and to counsel and support the Administrative Director.

Quality management by the Scientific Advisory Board

The Scientific Advisory Board (SAB) evaluates about one third of IFW's research programme annually. In this way, SAB evaluates the institute's scientific performance covering all research projects of the institute in the course of three years.

Implementation of recommendations from the last external evaluation

IFW responded to the 8 main recommendations summarised in the statement of the Senate of the Leibniz Association from 2008 (highlighted here in italics) as follows:

1. *Further incorporation of the Institute of Integrative Nanoscience into IFW's research programme:* According to IFW, the Institute of Integrative Nanoscience *(IIN)* has become an invaluable and integral partner within IFW Dresden and the university landscape in Saxony. IIN has made substantial contributions to the research development and visibility of IFW Dresden as a whole.
2. *Chemistry should be incorporated into materials development more intensively:* In January 2012, the new department „Chemistry of functional materials" was established at the Institute for Complex Materials. It bundles activities on corrosion and hydrogenation, magneto-electrochemistry, regenerative energy storage systems and chemical element analyses. In December 2009, the "Center for Spectroelectrochemistry" was founded. It consolidates research facilities for spectroscopic studies of the electron transfer phenomena in organic and metalorganic molecular material. Its expertise and the facilities are particularly in demand by industrial partners.
3. *IFW members should intensify their guest visits at other institutions:* IFW states that, during the last seven years, guest visits of IFW staff members at other institutions have been considerably intensified (see Section 4).

4. *IFW should increase the revenue from licensing:* In 2007, revenues due to license agreements amounted to 22.4 k€. In the years 2011 – 2013, revenues ranged from 22 k€ to 47 k€ per year.
5. *IFW should increase revenue from direct industry cooperation; intensify collaborations with SME; support spin-off formation:* In the years 2007-2013, IFW maintained collaborations with numerous industrial partners. Among them are small and medium-sized enterprises (SMEs) but also renowned representatives of large-scale industry. The relationship with SMEs has in particular been strengthened since March 2011, when the institute became a member of the Federal Association of Medium-Sized Businesses (*Bundesverband mittelständischer Wirtschaft - BVMW*). Revenues from industry cooperation are tabled in Appendix 3. IFW fosters the creation of spin-offs and is committed to the "Leibniz Catalogue for the Support of Spin-offs by Employees" (*Leibniz-Katalog für Unterstützungsmaßnahmen zu Mitarbeiterausgründungen*). So far, the companies evico (2004), evico magnetics (2006), ScIDre (2009) and BelektroniG (2010) have successfully emerged from the Institute.
6. *(a) SAB should be more involved in the appointment of managing staff:* According to the by-laws, SAB consults the Board of Trustees and the Executive Board in recruiting directors for the IFW institutes.

   (b) Increase the portion of women in leading scientific positions: Since 2007, the number of female department heads has increased from one to two. Two out of three Emmy Noether-Junior Research Groups established at IFW Dresden during the reporting period are led by women.
7. *The budget should be made more flexible wherever possible, particularly with regard to the staff appointment scheme (Stellenplan). It should also be made possible to use annual funds for multiple years:* IFW is bound to a staff appointment scheme (*Stellenplan*), a change is expected with the next programme budget in 2015/2016. In addition to the general management principles, funds for investments and operation are transferable unless otherwise stipulated in fund planning.
8. *IFW should make more use of its programme budget as a flexible steering tool for its scientific development:* As a consequence of the last evaluation the programme budget has been implemented successfully at IFW. It now is central for steering the institute's scientific development.

Appendix 1

Organisational Chart

Leibniz Institute for Solid State and Materials Research Dresden

IFW — Member of the Leibniz Association — Zertifikat seit 2007 audit berufundfamilie

General Meeting

Scientific Advisory Board
Head: Prof. Dr. Maria-Roser Valenti, J.-W. Goethe-Univ. Frankfurt

Board of Trustees
Head: MR Joachim Linek, SMWK

Scientific-Technical Council
Head: Dr. Hagen Schmidt -278

Executive Board

- Scientific Director: Prof. Dr. Jürgen Eckert; Ass.: Dr. Carola Langer -234; Secr.: Brit Präßler-Wüstling -100
- Administrative Director: Hon.-Prof. Dr. h. c. Rolf Pfrengle; Ass.: Katja Backhaus-Nousch -160; Secr.: Anja Hänig -200

Support Staff

- Public Relation, Media (PR): Dr. Carola Langer -234
- Project Funding, EU-office (FF): Dipl.-Ing. Ök. MB (TU) Birgit Benz -770
- Knowledge and Technology Transfer (WTT): Dr. Uwe Siegel -424
- Internal Auditor (IR): Dipl.-Betriebsw. (FH) Stefan Leipnitz -876
- Safety Officer (SI): M. Sc. Andrej Kraus -359

Institute for Solid State Research
Prof. Dr. Bernd Büchner -808
Secr.: Kerstin Höllerer -300, Manja Maluck -805

- 11 Electronic and Optical Properties: Prof. Dr. Martin Knupfer -544
- 12 Magnetic Oxides and Intermetallics: Prof. Dr. Bernd Büchner -808
- 13 Chemical Vapor Deposition: Dr. Albrecht Leonhardt -299
- 14 Electrochemistry and Conducting Polymers: Prof. Dr. Bernd Büchner -808
- 15 Magnetic and Acoustic Resonances: Prof. Dr. Bernd Büchner -808

Institute for Metallic Materials
Prof. Dr. Ludwig Schultz -101
Secr.: Katja Clausnitzer -104, Svea Fleischer -102

- 21 Magnetism and Superconductivity: Prof. Dr. Ludwig Schultz -101
- 22 Metal Physics: Dr. Jens Freudenberger -550
- 23 Superconducting Materials: Prof. Dr. Ludwig Schultz -101
- 24 Magnetic Microstructures: Prof. Dr. Rudolf Schäfer -223
- 25 Metastable and Nanostructured Materials: Dr. Bernd Rellinghaus -754
- Location Niedersedlitz, Info Center SupraTrans: Prof. Dr. Ludwig Schultz -101

Institute for Complex Materials
Prof. Dr. Jürgen Eckert -602
Secr.: Brit Präßler-Wüstling -100, Nicole Wiesner -217

- 31 Micro- and Nanostructures: Dr. Thomas Gemming -298
- 32 Structure Research: Dr. Norbert Mattern -367
- 33 Chemistry of Functional Materials: Dr. Annett Gebert -275
- 34 Metallic Glasses and Composite: Dr. Uta Kühn -402

Institute for Integrative Nanosciences
Prof. Dr. Prof. h. c. Oliver G. Schmidt -800
Secr.: Ulrike Steere -810

- 41 Strained Nanoarchitectures: Prof. Dr. Prof. h. c. Oliver G. Schmidt -800
- 42 Magnetic Nanomembranes: ERC-Group: Shapeable Magnetoelectronics, Dr. Denys Makarov -648
- Location Chemnitz Smart Systems Campus: Prof. Dr. Prof. h. c. Oliver G. Schmidt -800

Institute for Theoretical Solid State Physics
Prof. Dr. Jeroen van den Brink -400
Secr.: Grit Rötzer -380

- 51 Theoretical Solid State Physics: Prof. Dr. Jeroen van den Brink -400
- 52 Numerical Solid State Physics and Simulation: Dr. Manuel Richter -360
- 53 Theory of Correlated Quantum Matter: Emmy-Noether Young Researches Group "spin-orbital systems", Dr. Maria Daghofer -626

Research Technology Division
Prof. Dr. Dirk Lindackers -580
Secr.: Nicole Büttner -505

- 71 Electrical Engineering and Electronics: Karsten Peukert (Komm.) -509
- 72 Mechanical Engineering: Dr. Ralf Voigtländer -121
- 73 Information Technologies: Dr. Herbert Zimmermann -345

Administration
RA Elmar Liese -620
Secr.: Katrin Kempe -621

- 81 Finance Deparment: Dipl.-Phil. Martina Schmidt -457
- 82 Human Resources: Dipl.-Ing.-Ök. Klaus-Dieter Faulian -578
- 83 Purchase and Disposal: Dipl.-Ing. Wolfram Jacob -383
- 84 Information and Documentation: Dipl.-Bibl. Nadja Röder -366
- 85 Facility Management: Ing. Werner Effenberg -201

Labour Council
Head: Marek Ulbrich -306

Equal Opportunity Commissioner
Projektleitung AG Beruf und Familie, Gelia Preuß -583

Confidential Representative (Ombudsperson)
Prof. Dr. R. Schäfer -223

Representative Body for Disabled Employees
Dr. Hartmut Siegel -507

Youth and Trainee Representative Council
Stefanie Berndt -730

Patent
Patent Agents Rauschenbach, tel.: 0351 475 99 90

Company Medical Officer
Dr. Dieter Jährig, tel.: 03591 326 63-0

Data Security Officer
Dr. Ralph Wagner, tel.: 0351 810 31 50

Materialforschungsverbund Dresden (MFD)
Dr. Kerstin Dittes, tel.: 0351 465 92 83

Contact

Visitor's Address	Mailing Address	Phone	Internet
Helmholtzstrasse 20, D-01069 Dresden	PF 27 01 16, D-01171 Dresden	Tel.: +49 351 46 59-0, Fax: +49 351 46 59-540	www.ifw-dresden.de, postmaster@ifw-dresden.de

Date: 01/2014

Appendix 2

Publications and patents

	Period		
	2011	**2012**	**2013**
Total number of publications	**479**	**445**	**417**
Monographs	0	0	1
Individual contributions to edited volumes	35	28	10
Articles in peer-reviewed journals	442	415	405
Editorship of edited volumes	2	2	1
Number of publications per full-time equivalent (FTE) in 'research and scientific services' (not including doctoral candidates)	3.9	3.6	3.4

Industrial property rights (2011–2013) [1)]	Granted	Registered
Patents	31	78
Other industrial property rights	0	0
Exploitation rights/licences (number)	2	

[1] Concerning financial expenditures for revenues from patents, other industrial property rights and licences see Appendix 3.

Appendix 3

Revenue and Expenditure

	Revenue	2011			2012			2013[1]		
		k€	%	%	k€	%	%	k€	%	%
Total revenue (sum of I., II. and III.; excluding DFG fees)		**37,599.11**			**37,418.34**			**39,568.37**		
I.	**Revenue (sum of I.1., I.2. and I.3)**	**36,484.53**	*100.00*		**37,140.22**	*100.00*		**39,284.58**	*100.00*	
1.	Institutional funding (excluding construction projects and acquisition of property)	26,029.05	*71.34*		27,940.30	*75.23*		29,328.70	*74.66*	
1.1	Institutional funding (excluding construction projects and acquisition of property) by Federal and *Länder* governments according to AV-WGL	26,029.05			27,940.30			29,328.70		
1.1.1	*Proportion of these funds received through the Leibniz competitive procedure (SAW)* [4]	*677.20*			333.00			0.00		
1.2	Institutional funding (excluding construction projects and acquisition of property) not received in accordance with AV-WGL	0.00			0.00			0.00		
2.	Revenue from project grants	8,738.01	*23.95*	*100.00*	9,069.93	*24.42*	*100.00*	9,813.61	*24.98*	*100.00*
2.1	DFG	3,982.38		*45.58*	4,207.23		*46.39*	5,445.80		*55.49*
2.2	Leibniz Association (competitive procedure) [2]	206.21		*2.36*	425.57		*4.69*	414.52		*4.22*
2.3	Federal, *Länder* governments	2,148.83		*24.59*	1,233.54		*13.60*	1,211.24		*12.34*
2.4	EU	475.53		*5.44*	628,71		*6.93*	1,550.79		*15.80*
2.5	Industry	1,531.18		*17.52*	1,766,19		*19.47*	850.53		*8.67*
2.6	Foundations	367.93		*4.21*	801.22		*8.83*	311.18		*3.17*
2.7	Other sponsors	25.95		*0.30*	7.47		*0.08*	29.55		*0.30*
3.	Revenue from services	1,717.47	*4.71*		129.99	*0.35*		142.27	*0.36*	
3.1	Revenue from commissioned work	1,684.47			82.95			120.16		
3.2	Revenue from publications	0.00			0.00			0.00		
3.3	Revenue from exploitation of intellectual property for which the institution holds industrial property rights (patents, utility models etc.)	33.00			47.04			22.11		
3.4	Revenue from exploitation of intellectual property without industrial property rights	0.00			0.00			0.00		
II.	**Miscellaneous revenue** (e.g. membership fees, donations, rental income)	**314.58**			**278.12**			**283.79**		
III.	**Revenue for construction projects** (institutional funding by Federal and *Länder* governments, EU structural funds, etc.)	**800.00**			**0.00**			**0.00**		

	Expenditures	k€	k€	k€
Expenditures (excluding DFG fees)		37,599.11	37,418.34	39,568,37
1.	Personnel	21,151.21	21,108.86	21,343.34
2.	Material resources	6,845.27	6,564.06	6,790.12
2.1	*Proportion of these expenditures used for registering industrial property rights (patents, utility models etc.)*	94.12	102.26	79.18
3.	Equipment investments and acquisitions	4,768.67	5,062.25	6,494.41
4.	Construction projects, acquisition of property	445.80	989.51	1,811.52
5.	"Reserves" (e.g. cash assets, unused funds[3])	4,388.16	3,693.68	3.128,98
DFG fees (if paid for the institution – 2.5 % of revenue from institutional funding)		638.80	689.70	725.30

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[1] Preliminary data: yes, (Überleitungsrechnung ohne Bau/DFG)

[2] Competitive procedure of the Leibniz Association: until 31 December 2010, funds allocated through this procedure were designated as institutional funding. Since 1 January 2011, the Leibniz Association has granted these funds as project grants.

[3] Cash assets from third-party funding and cooperation orders.

Appendix 4

Staff

(Basic financing and third-party funding / proportion of women (as of: 31/12/2013)

	Full time equivalents		Employees		Female employees	
	Total	3rd-party funding	Total	temporary contracts	Total	temporary contracts
	Number	Percent	Number	Percent	Number	Percent
Executive Board	2	0%	2	100%	0	0%
Scientific Director (*incl. in Professors/Direct. below*)	*(1)*	*0%*	*1*	*100%*	*0*	*0%*
Administrative Director	1	0%	1	100%	0	0%
Research and scientific services	198.05	58%	262	78%	73	88%
Professors / Direct. (C4, W3 or equivalent)	5.00	0%	5	20%	0	0%
Professors / Direct. (C3, W2, A16 or equiv.)	0.00	0%	0	0%	0	0%
Academic staff in executive positions (A15, A16, E15 or equiv)	12.55	24%	13	23%	4	50%
Junior research group leaders / junior professors/ post-doctoral fellows (C1, W1, A14, E14 or equiv)	17.10	0%	18	6%	3	0%
Scientists in non-exec. positions (A13, A14, E13, E14 or equiv)	89.50	57%	103	75%	28	86%
Doctoral candidates (A13, E13, E13/2 or equiv)	73.90	82%	123	100%	38	100%
Service positions	77.60	4%	86			
Laboratory (E9 to E12,upper-mid-level service)	20.60	5%	23			
Laboratory (E5 to E8, mid-level service)	46.25	4%	51			
secretaries/assistants (E4 to E8, mid-level service)	8.75	0%	9			
Library (E9 to E12, upper-mid-level service)	2.00	0%	3			
Support staff	11.50	38%	12			
Staff positions (from E13, senior service)	5.00	50%	6			
Staff positions (E9 to E12, upper-mid-level service)	5.50	27%	6			
Research Technology Division	39.20	5%	42			
secretaries/assistants (E4 to E8, mid-level service)	1.00	0%	1			
Head of Research Technology	1.00	0%	1			
Technik/Entwicklung (from E13, executive + senior)	5.00	17%	5			
Technik/Entwicklung (E9 to E12upper-mid-level service)	8.70	12%	10			
Workshops (E5 to E8, mid-level service)	16.00	0%	17			
IT (E9 to E12, upper-mid-level service)	7.50	0%	8			
Administration	29.15	5%	33			
secretaries/assistants (E4 to E8, mid-level service)	1.85	0%	2			
Head of the administration	1.00	0%	1			
Internal administration (fin. administration, HRM etc.) (from E13, staff in executive positions + senior service)	2.50	0%	4			
Internal administration (financial administration, personnel etc.) (E9 to E12, upper-mid-level service)	6.80	0%	9			
Internal administration and Building service (E4 to E8)	17.00	9%	17			
Student assistants + scientific assistants	20.60	48%	81			
Trainees	21.00	0%	21			
BA-students	1.00	0%	1			
Scholarship recipients at the institution	47.00	58%	47		13	
Doctoral candidates	18.00	78%	18		3	
Post-doctoral researchers	27.00	41%	27		9	
Others (e. g. Master students)	2.00	100%	2		1	

21 November 2014

Annex B: Evaluation Report

Leibniz Institute for Solid State and Materials Research (IFW) Dresden

Contents

1. Summary and main recommendations

IFW's mission is to pursue fundamental research as well as application-oriented research in the field of solid state matter and materials science. The institute achieves a good balance between the use of theoretical and experimental approaches to elucidating the electronic structure of quantum- and nanoscale materials with a focus on the characterisation of their physical and chemical properties. One of the main objectives is to generate new applications based on these functional materials, on the physical effects investigated and on the novel devices developed. IFW fulfils this mission extremely successfully and has gained a place as one of the world's leading research institutes in this field.

With institutional funding of approx. 29.3 million EUR and a total of 436 staff and 47 scholarship recipients, IFW is one of the largest institutions in the Leibniz Association. It comprises five institutes, each headed by a director who holds a joint appointment at a university. IFW is managed by the Executive Board, which consists of the Administrative Director and the Scientific Director. The latter, up to now, has been director of one of the five IFW institutes. Scientific work is currently conducted across all IFW institutes in five research areas which are themselves split up into 13 subdivisions. Most are rated as "very good to excellent" (2x "excellent"; 8x "very good to excellent"; 1x "very good"; 1x "good to very good"; 1x "good").

Research results are excellently published, in some cases in highest-ranking journals. Income from third-party funding is also generally very good. It has increased continually in the last few years and now accounts for almost a quarter of the budget with DFG funding constituting the largest proportion. One of the directors acquired an ERC Advanced Grant. IFW is an attractive institution for junior researchers. The institute is home to three Emmy Noether Junior Research Groups and one group financed by an ERC Starting Grant. One IFW scientist was awarded an ERC Junior Research Group with which he works now at the Max Planck Institute for Intelligent Systems in Stuttgart.

IFW cooperates intensively with the universities in Dresden and Chemnitz. This includes joint appointments of all five directors, scientific projects and joint use of infrastructure as well as cooperation in Clusters of Excellence, Collaborative Research Centres and TU Dresden's Institutional Strategy (*Zukunftskonzept*) in the context of the Excellence Initiative. Joint training is also provided for approx. 140 doctoral candidates who receive very good supervision from IFW.

Due to changes in management as well as scientific developments in solid state matter and materials research, IFW is planning to fundamentally restructure its research programme. This plan is welcomed, and the approaches presented in the evaluation package for continuing to develop the institute are convincing. How they are supposed to be implemented, however, has remained largely unclear. This is due to grave differences of opinion amongst the directors that emerged in the course of planning. It was not possible to overcome these conflicts internally and IFW found itself in a serious management crisis, which culminated in the resignation of IFW's Scientific Director.

Against this backdrop, in July 2014, shortly before the evaluation visit, IFW's Board of Trustees decided to fill the position of Scientific Director – initially for one year – with an experienced scientific leadership figure who was recruited externally rather than from the circle of institute directors as had been the case in the past.

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

General concept and profile (Section 2)

1. The scientific ideas and approaches for continuing IFW's development presented in the evaluation package are convincing. At present, however, it is not clear how these ideas are to be prioritised and implemented. Above all, it is not transparent which of the institute's human and financial resources are to be allocated to which research tasks and how cooperation between the subdivisions is to be organised within the new research programme.

   The evaluation group was informed that the Board of Trustees decided on the appointment of an external scientist to the position of IFW's Scientific Director, seen as the best possible way of responding to the management crisis at the institute. The newly appointed Scientific Director will be responsible for scientific management. Under his leadership and responsibility it must now be decided which reforms and changes are necessary at IFW in order to be able to implement a research programme supported by everyone and thus maintain IFW's high scientific capabilities. The Review Board expects all institute directors to collaborate constructively in this process. As a consequence of the intense discussions within the review board, it is also expected that the process is closely monitored by the Scientific Advisory Board as well as by the Board of Trustees.

2. The proportion of income for project funding deriving from industry should be increased and clear goals for industrial funding and research project participation should be formulated. In order to achieve this, the institute should optimize its strategy regarding collaborations with partners in industry and combine it with an institute-wide patents strategy.

Collaboration and networking (Section 4)

3. It would be desirable if more IFW scientists were to spend longer periods of time at other institutions.

Staff development and promotion of junior researchers (Section 5)

4. IFW must continue to significantly drive its efforts to increase the proportion of women at all levels.

5. For some doctoral candidates there are structured doctoral programmes. It would be desirable to ensure that all doctoral candidates at IFW had the opportunity to take part in structured programmes. At 4.5 years, the average length of doctoral studies is too long and should be shortened.

2. General concept and profile

Development of the institution since the last evaluation

IFW's mission is to pursue fundamental research as well as application-oriented research in the field of solid state matter and materials science. The institute achieves a good balance between the use of theoretical and experimental approaches to elucidating the electronic structure of quantum- and nanoscale materials with a focus on the characterisation of their physical and chemical properties. One of the main objectives is to generate new applications based on these functional materials, on the physical effects investigated and on the novel devices developed. IFW fulfils this mission extremely successfully and has gained a place as one of the world's leading research institutes in this field.

IFW comprises five institutes, each of which is headed by a director with a joint appointment at a university. Changes and enhancements in the direction of IFW's research programme were initiated by appointing two new directors. Shortly before the last evaluation in March 2007, the Institute of Integrative Nanosciences was established and a new director appointed in collaboration with TU Chemnitz. The new work on nanosciences blends in extremely well with IFW's research programme. In October 2009, a new director was appointed (together with TU Dresden) to replace the head of the Institute of Theoretical Solid State Physics who was retiring. This change in leadership was handled convincingly.

IFW's five institutes jointly address five research areas in a matrix structure. Scientific work within the research areas is conducted in 13 subdivisions (see Chapter 3 for a detailed evaluation of the subdivisions). In past years, this organisational structure proved appropriate for implementing the research programme.

Results

Scientific work in the 13 subdivisions is largely rated as "very good to excellent" (2x "excellent"; 8x "very good to excellent"; 1x "very good"; 1x "good to very good"; 1x "good"). The publication record is excellent. Between 2011 and 2013, more than 1200 scientific articles were published in peer-reviewed journals, including a large number that appeared in highest-ranking journals like journals of the *Nature* group and *Physical Review Letters*. In most of the areas of solid state matter and materials research in which it is active, IFW has a very high international reputation. Furthermore, an important pillar of the institute's quality is the Research Technology Division which tailor-makes research equipment for in-house use.

The overall amount and composition of third-party income is very good. The institute is involved in more than 150 DFG-funded projects, including projects in 12 Priority Programmes, three Collaborative Research Centres, and five Research Units.

One of the directors acquired an ERC Advanced Grant. IFW is also an attractive institution for junior researchers. The institute is home to three Emmy Noether Junior Research Groups and one group financed by an ERC Starting Grant. One IFW scientist was awarded an ERC Junior Research Group with which he now works at the Max Planck Institute for Intelligent Systems in Stuttgart.

In order to be a sought-after partner for collaborations with industry, IFW holds an extensive portfolio of patents. It is indicative of the institute's achievements that IFW was granted 31 patents in the period 2011 to 2013; a further 78 were filed.

The institute's engagement with applications is documented by its successful spin-off activities. In 2009, Scientific Instruments Dresden GmbH, ScIDre, was founded as a spin-off from the Research Technology Department and in 2010, BeletroniG as a spin-off from scientific work. This is a positive development. Even before the last evaluation, the two companies, evico and evico magnetics, were founded in 2004 and 2006 respectively.

Strategic work planning for the next few years

It is welcomed that the Executive Board and the five directors intend to significantly restructure the institute. The reasons stated in the evaluation package are certain scientific developments as well as the replacement of one of the directors in 2014 due to retirement (see also Chapter 5 on the refilling of this position). **The scientific ideas and approaches for continuing IFW's development presented in the evaluation package are convincing. At present, however, it is not clear how these ideas are to be prioritised and implemented. Above all, it is not transparent which of the institute's human and financial resources are to be allocated to which research tasks and how cooperation between the subdivisions is to be organised within the new research programme.** This lack of clarity is a result of the grave differences of opinion amongst the directors that emerged in the course of planning for the coming years. It was not possible to overcome these conflicts internally and IFW found itself in a serious management crisis, which culminated in the resignation of IFW's Scientific Director.

IFW is managed by the Executive Board, which consists of the Administrative Director and the Scientific Director. Until now, the Board of Trustees regularly appointed one of the institute directors to the position of IFW's Scientific Director. Some months before the evaluation visit, and in the wake of the conflicts of the previous months, the Scientific Director asked to be released from this position and revert to his role as one of the institute directors.

Against this backdrop, in July 2014, immediately before the evaluation visit, the position of the Scientific Director was filled with an experienced scientific leadership figure who was recruited externally rather than from the circle of institute directors as had been the case in the past. The Board of Trustees consulted both the Scientific Advisory Board and other scientists with ample experience in managing research institutions in coming to a decision. It is welcomed that the administrative member of the Executive Board is willing to postpone his retirement to ensure the continuity of the Executive Board. **The evaluation group was informed that the Board of Trustees decided on the appointment of an external scientist to the position of IFW's Scientific Director, seen as the best possible way of responding to the management crisis at the institute. The newly appointed Scientific Director will be responsible for scientific**

management. Under his leadership and responsibility it must now be decided which reforms and changes are necessary at IFW in order to be able to implement a research programme supported by everyone and thus maintain IFW's high scientific capabilities. The Review Board expects all institute directors to collaborate constructively in this process. As a consequence of the intense discussions within the review board, it is also expected that the process is closely monitored by the Scientific Advisory Board as well as by the Board of Trustees.

Appropriateness of facilities, equipment and staffing

IFW's institutional funding is adequate and amounted to approx. 29.3 million EUR in 2013. The income from project grants increased from 4 million EUR (14% of the overall budget) in 2006, to 9.8 million EUR (25%) in 2013. At 5.4 million EUR, DFG-funding accounted for the largest proportion. The overall amount and composition of third-party income is very good. The research work and collaborative projects complement IFW's research excellently.

Thanks to its engagement with applications, IFW also generates income from industry and marketing intellectual property. Expenditure on patents, however, still outstrips the concomitant income by more than twice as much. IFW's patents strategy focusses primarily on achieving access to partners in industry. To this extent, expenditure on patents and other property rights should also be seen in relation to income from projects involving industry. This strategy is sound, but is not reflected sufficiently in the income from industry for funding research. **The proportion of income for project funding deriving from industry should be increased and clear goals for industrial funding and research project participation should be formulated. In order to achieve this, the institute should optimize its strategy regarding collaborations with partners in industry and combine it with an institute-wide patents strategy.**

IFW constantly upgrades and modernises its equipment and facilities. This is very much welcomed and also needed in order to maintain the outstanding infrastructure. As already established by the Scientific Advisory Board, the technology is thus state of the art and internationally highly competitive.

3. Subdivisions of IFW

Subdivision 1 "Superconductivity and superconductors: Electronic structure and fundamentals" (13.26 FTE)

Subdivision 1 studies the electronic structure and underlying mechanisms of superconductivity and competing phases in a variety of superconductors and related materials. The cooperation between the experimental and theoretical scientists in the subdivision is outstanding, a fact that is reflected in the large number of joint publications. Based on this close cooperation, the subdivision produces important fundamental results which are not only of great relevance to the other subdivisions at IFW but also to the international community.

In the last few years, excellent work has been done on a wide range of topics including cuprates, ruthenates, heavy fermion systems and elemental as well as other conventional superconductors. Particular mention should be made of the work on iron-based superconductors, which has been conducted for some time. It achieves international excellence and receives funding, amongst others, from two major DFG programmes: scientists in Subdivision 1 coordinate the DFG Priority Programme, "High Temperature Superconductivity in Iron Pnictides" (funding period 2011-2015); the subdivision also participates in the DFG Graduate School "Itinerant magnetism and superconductivity in intermetallic compounds" (funding since 2011), which is run jointly with TU Dresden and two Max Planck institutes in Dresden.

Overall, third-party funding income is very high, particularly from the DFG. The publication record is outstanding, both in terms of quantity and quality.

In summary, Subdivision 1 is rated as "excellent".

Subdivision 2 "Superconductivity and superconductors: Materials and applications" (26.5 FTE)

Subdivision 2 studies application-relevant properties of superconductors and develops demonstrator systems as well as practical conductors based on superconducting materials. This work convincingly combines fundamental research with the development of industrial applications. Excellent results have been produced in various fields during the last few years. The work related to high-trapped fields in bulk MgB_2 or in the area of thin-film growth of iron-based superconductors was particularly impressive.

The overall publication record is very good. Furthermore, as a result of the outstanding work on applications, the subdivision acquired ten industrial property rights in the period 2011 to 2013. Third-party funding income is very high. In addition to funding from the DFG (the subdivision is also involved, amongst other things, in the DFG Graduate School, see Subdivision 1), funding was also acquired from the EU and industry.

Subdivision 2 is rated as "very good to excellent".

Subdivision 3 "Magnetism and magnetic materials: Theoretical fundamentals" (11.06 FTE)

In this subdivision, the theoretical fundamentals of magnetism and magnetic materials are studied in close relation to method development. The results are obtained by a number of different analytical and numerical methods. Whilst some of the excellent work is purely theoretical, most of it arises from collaborations with experimentalists at IFW and beyond.

Particular mention should be made of the work on the analysis and modelling of resonant inelastic X-ray spectroscopy. In this field, IFW is a world leader, and the results achieved are of great significance to experimental scientists, too. Other very good work is conducted on skyrmionic and helical phases in non-centrosymmetric magnets.

The publication record is very good with regular publications in high-impact journals. Third-party funding income is also very high, particularly from the DFG. Since 2009, the subdivision has hosted an Emmy Noether Junior Research Group.

Subdivision 3 is rated as “very good to excellent”.

<u>Subdivision 4 “Magnetism and magnetic materials: Experimental fundamentals”</u> (31.71 FTE)

Subdivision 4 experimentally investigates materials in which strong electron-electron correlations and entanglement of spin, charge, orbital and lattice degrees of freedom give rise to novel quantum magnetic phases of matter and exotic excitations. The subdivision repeatedly produces important insights into the fundamental physics of the new magnetic phenomena in the materials investigated. The potential of these research findings to generate technological applications is studied and, in many cases, leads to the development of new technologies as well as materials.

The subdivision’s publication record is very good with regular publications in high-impact journals. Third-party funding income is also very high, predominantly from the DFG. In 2008 and 2010 respectively, Emmy Noether Junior Research Groups decided to be active in this subdivision. Furthermore, from 2009 to 2013, the Marie Curie Initial Training Network “Low-Dimensional Quantum Magnets for Thermal Management” (LOTHERM) was coordinated. It comprised nine full European partners from academia and industry and two industrial partners.

Subdivision 4 is rated as “very good to excellent”.

<u>Subdivision 5 “Magnetic materials”</u> (20.65 FTE)

The research in Subdivision 5 covers a wide range of topics from nanoparticles, nanowires and thin films to bulk materials and their composites. The subdivision has a clear application strategy and is an excellent model for the translation of fundamental research findings to industrial practice. The goal is to produce environmentally friendly and sustainable magnetic materials as well as to develop next-generation magnetic materials and devices. With this focus, the subdivision is very well positioned.

Activities in the field of technology transfer are excellent and have led to, amongst other things, the acquisition of four industrial property rights since 2011. Research in this subdivision is very good and has been appropriately published. Third-party funding income is high, predominantly from the DFG. From 2006 to 2012, scientists in this subdivision coordinated the DFG Priority Programme “Change of microstructure and shape of solid materials by external magnetic fields”. The DFG Priority Programme “Caloric effects in ferroic materials: New concepts for cooling” has been coordinated since 2012.

Subdivision 5 is rated as “very good to excellent”.

<u>Subdivision 6 “Magnetics and magnetic materials: Magnetic microstructures”</u> (10.32 FTE)

Just like Subdivision 5, Subdivision 6 also convincingly translates theoretical and experimental research results into applications. The palette ranges from ab-initio calculations via developing characterisation methods to materials design. The impressive results achieved by this relatively small group are also of great importance to other subdivisions at IFW.

As a whole, the research work is rated as very good, although the number of publications could be increased. In terms of third-party income, DFG and industry account for the major share; an overall increase would, however, be desirable.

The major strength of this subdivision lies in its focus on applications, which often lead to outstanding practice-related developments. The excellent international work on magneto-optical Kerr microscopy, for example, generated a spin-off (evico magnetic). This company develops instruments for magnetic analysis and imaging as well as novel synthesis tools for functional materials. It has customers all over the world. Subsequent work on Kerr microscopy as well as on skyrmions in chiral magnetic materials promises to produce outstanding results in the field of applications.

Subdivision 6 is rated as “very good to excellent”.

<u>Subdivision 7 “Carbon nanostructures, conducting polymers, molecular magnets”</u> (12.75 FTE)

Subdivision 7 investigates novel functional nanomaterials that are composed of nanostructures solely based upon carbon (fullerenes, carbon nanotubes, graphene) as well as the combination of carbon-based nanostructures with other materials. Specific materials are identified, optimised and modified, either addressing fundamental questions or meeting the requirements for different applications. The convincing work conducted in this subdivision spans a large area of well-chosen projects.

Like many of IFW’s other subdivisions, Subdivision 7 achieves a very good balance between fundamental work and application-related development. In many areas outstanding and, in some cases, internationally ground-breaking findings have emerged. In the field of biomedical applications of functionalised carbon nanostructures, in particular, the subdivision is a world leader. By comparison, the work on graphene does not reach the same level.

The overall publication record is very good. Furthermore, between 2011 and 2013, the subdivision acquired two industrial property rights. Third-party funding income is very high, especially from the DFG.

Subdivision 7 is rated as “very good to excellent”.

<u>Subdivision 8 “Bulk amorphous metals, solidification and crystallisation”</u> (38.79 FTE)

This subdivision focusses on physical concept-based material design for applications as well as related basic research. The group has impressive material design concepts that are based on excellent fundamental research. This balanced combination of fundamental research and applications exemplifies how a profound understanding of physical concepts can produce tailor-made materials. The results connected to metastable phase formation in undercooled liquids and the work related to fully crystalline high-strength Fe-based alloys are especially impressive. In addition to experimental work, the subdivision is also active in the field of modelling and simulations, which follow on ideally from the experiments. It would be desirable to foster the mutual exchange of expertise in materials design with other groups in house, such as those working with magnetocaloric materials, as properties of materials like ductility are extremely important for their work as well.

The methods and expertise established in this subdivision are highly sought-after in branches of industry like the steel industry, which require materials with high strength and ductility. Thus the subdivision has good connections with industrial partners.

The publication record is excellent and scientific work is meaningfully complemented by third-party funded projects. Between 2011 and 2013, the subdivision also acquired six industrial property rights.

The overall performance of Subdivision 8 is rated “excellent”.

Subdivision 9 “Corrosion, electrochemical processing and hydrogen” (19.52 FTE)

The work of this subdivision is mainly focussed on magnetoelectrochemistry and, in particular, on corrosion in the presence of magnetic fields and corrosion of magnetic materials. The experimental work is very convincing. Special mention should be made of the studies on the corrosion of metal glass phases. The technique for electrochemical micro-structuring of bulk-glass forming alloys, developed by the subdivision, is particularly impressive; the work on hydrogen storage materials is also convincing.

The publication record is very good. Research is appropriately complemented by third-party projects, a large proportion of which are funded by the DFG and EU. Positive note was taken of the fact that scientists in this subdivision are involved in a DFG-funded CRC/Transregio on Ti-based alloys for biomedical applications. Junior researchers are an integral part of group activities.

The performance of Subdivision 9 is rated as “very good”.

Subdivision 10 “Electrochemical energy storage systems / Li-ion batteries” (15.33 FTE)

The focus of this subdivision is on the investigation of physical concepts for electrochemical energy storage. Initially, the scientific topics dealt with amorphous metals, which generated very good results based on convincing and innovative concepts.

Since then, the scope has been broadened and now a large range of materials is tested for its response to an electrochemical environment. For this purpose, the subdivision has set up high-quality analytical tools like nuclear magnetic resonance spectroscopy (NMR) to study Li insertion. The subdivision’s scientific work is appropriately published and meaningfully complemented by third-party funded projects.

Overall, work mainly concentrates on anode materials. The materials that are analysed in this context are promising, e.g. alloys, but nonetheless, a greater focus on application-related research is needed. Scientific questions should be more directly related to the specific demands of applications in order to exploit the potential of the projects more effectively.

The performance of Subdivision 10 is rated as "good".

Subdivision 11 "3D micro/nano architectures" (32.6 FTE)

This subdivision explores the fundamental properties of rolled-up nanomembranes. The necessary techniques and expertise were brought into IFW with the establishment of the Institute of Integrative Nanoscience in March 2007. This development is greatly welcomed because it means a broad palette of application-related and innovative research work which also has a major scientific impact.

Mention should also be made of a junior research group within this subdivision, which was founded on the strength of an ERC Starting Grant. The group produces impressive scientific results and, moreover, has a very clear understanding of and reflects upon how these results may connect to applications. During the reporting period, a second ERC Starting Grant was awarded to another scientist in this subdivision, who now heads a research group at the Max Planck Institute for Intelligent Systems in Stuttgart.

In general, the subdivision is very creative, which is documented by high-impact publications. Apart from the convincing work on applications, a lot of outstanding fundamental research has also been conducted, achieving a very good balance between the two. The subdivision's scientific objectives are convincing. It can be assumed that this extremely positive development will continue.

Subdivision 11 is rated as "very good to excellent".

Subdivision 12 "Quantum dots" (13.04 FTE)

This subdivision aims to create state-of-the-art quantum dots (QD) and tune them by strain engineering. These activities also relate to very interesting results on single-photon-sources and work on the production of identical photons in terms of entanglement. Research activities include epitaxial growth, photonics, quantum transport, thermoelectrics, quantum optics and novel optoelectronic devices. Although the former leading scientist left the institute to take up an appointment at Johannes Kepler University Linz, IFW has convincingly and successfully managed to continue this line of research.

The group has extended its activities in quantum optics and provides all necessary competences in house. This development is appreciated and should be continued. Scientific topics are well chosen and the published results are very impressive. The amount of third-party funding is high.

Subdivision 12 is rated as "very good to excellent".

Subdivision 13 "SAW systems" (6.52 FTE)

Research in this subdivision is devoted to applications of surface acoustic wave (SAW) structures as well as related fundamental questions. The group has long-standing expertise which originally focussed on SAW filters and has been largely extended since then. Filter design and thus the design of related materials is still addressed in this subdivision as these topics are in great demand in industry. The group cooperates closely with different industrial partners in the joint funding of PhD candidates, for example, and thus contributes both to the overall visibility of IFW and to convincingly fulfilling IFW's mission. The subdivision's activities in micro acoustic fluidics produce good scientific work, although it would be desirable to employ more innovative ideas as well.

Overall, the performance is solid. Scientific topics in this subdivision are very closely related to applications. As such, it is positive to note that seven patents have been registered within the last three years.

Subdivision 13 is rated as "good to very good".

4. Collaboration and networking

Collaboration with universities

All five of IFW's institute directors hold joint professorships with a university, four at TU Dresden and one at TU Chemnitz. On top of this, five further management-level scientists as well as the Administrative Director hold adjunct (and one honorary) professorships at the technical universities in Dresden, Chemnitz, Freiberg and Bratislava.

IFW collaborates intensively on a large number of research projects with the two universities TU Dresden and TU Chemnitz, which also includes the sharing of research infrastructure. In the framework of the German Excellence Initiative, IFW was involved, amongst others, in two successful measures: the Institutional Strategy (*Zukunftskonzept*) "The Synergetic University" and the Cluster of Excellence "Center for Advancing Electronics Dresden (cfAED)".

At TU Chemnitz IFW is part of the Cluster of Excellence "Merge Technologies for Multifunctional Lightweight Structures – MERGE". In addition, the "Center for Materials, Architectures and Integration of Nano Membranes – MAIN" at TU Chemnitz is headed by an IFW director. In 2010, furthermore, IFW established research facilities on the TU's Smart Systems Campus.

At national level, too, IFW is excellently connected within the German science and higher education landscape.

Collaboration with other domestic and international institutions

Due to its close engagement with applications, IFW collaborates with many partners in industry and also works together closely with the Fraunhofer institutes in the Dresden area. These joint projects ideally complement IFW's research profile.

IFW's prestige as a European and international collaborative partner is demonstrated by the projects funded at EU level. Between 2011 and 2013, the institute was involved in 22 EU projects, ten of which it coordinated. IFW's involvement in six BMBF-funded projects in the same period complemented institutionally-funded research very convincingly.

Within the Leibniz Association, IFW is actively involved in the Leibniz Nano-Network, the Leibniz Research Alliance "Medical Technology: Diagnosis, Monitoring and Therapy" and the Leibniz Transfer Alliance Micro-Electronics.

International research partners also make intensive use of opportunities to spend time working at IFW in Dresden. In the period 2011 to 2013, over 200 researchers stayed at the institute for more than three months. **It would be desirable if more IFW scientists were to spend longer periods of time at other institutions.** From 2011 to 2013, only eight IFW scientists visited other institutions for longer than three months.

5. Staff development and promotion of junior researchers

Staff development and personnel structure

IFW employs a total of 436 staff (excluding student assistants and trainees) and hosts 47 scholarship recipients. Almost 80 percent of the staff are assigned to the five institutes in the fields of research and scientific services. The personnel structure is appropriate. The staff are highly motivated and the working atmosphere is good.

In the last seven years, two institute directors were newly appointed. The institute managed to recruit two highly-qualified individuals who have excellently complemented and extended IFW's research profile. The director of the Institute for Metallic Materials will retire in October 2014. IFW is currently negotiating for a successor.IFW is still bound by a staff appointment scheme (*Stellenplan*). It is welcomed that a change is expected in the next programme budget in 2015/2016.

Promotion of gender equality

At the end of 2013, none of the five institute directors was female. At the level of leading scientists, 4 of 13 (31%) positions were held by women. At the level below this, however, the proportion of women was only 18 percent. In 2013, IFW introduced flexible quotas in order to increase the proportion of female employees, as all Leibniz institutions are expected to do. **IFW must continue to significantly drive its efforts to increase the proportion of women at all levels.**

IFW has committed itself to the principles of equal opportunities and a work environment that supports a family-work balance. It is positive that, accordingly, the *berufundfamilie* Award was obtained in 2007, 2010 and again in 2013.

Promotion of junior researchers

Supervision for doctoral candidates at IFW is very good. The number of doctoral candidates increased from approx. 100 in 2006 to 140 in 2013. It is pleasing that, in addition to students from TU Dresden, the joint appointment with TU Chemnitz now means that students from the latter university also come to IFW to do their doctorates.

For some doctoral candidates there are structured doctoral programmes. IFW is involved in the International Research Training Group (*Internationales Graduiertenkolleg* 1215) “Materials and Concepts for Advanced Interconnects and Nanosystems”. **It would be desirable to ensure that all doctoral candidates at IFW had the opportunity to take part in structured programmes. At 4.5 years, the average length of doctoral studies is too long and should be shortened.**

The institute makes well-considered use of its contacts to partners in industry in the training of doctoral candidates. There are not only doctoral grants funded by collaborations with industry but also very good career opportunities for post-docs beyond university research.

Excellent working conditions are also available for post-doctoral junior researchers at IFW. The institute is home to three Emmy Noether Junior Research Groups and one group financed by an ERC Starting Grant. One IFW scientist was granted an ERC Junior Research Group with which he now works at the Max Planck Institute for Intelligent Systems in Stuttgart.

Vocational training for non-academic staff

It is extremely pleasing that IFW consistently trains approx. 20 individuals in a total of seven different occupational groups. This proactive attitude to vocational training was already expressly welcomed at the last evaluation and is due, not least, to the particular dedication of the Administrative Director who is also the representative for dual education and training in the Leibniz Association.

6. Quality Assurance

Internal quality management

All members of IFW are obliged to act in accordance with IFW’s binding guidelines for good scientific practice, which follow the Recommendations of the German Science Foundation for Safeguarding Good Scientific Practice. An ombudsperson is elected every two years.

As a consequence of the last evaluation, a programme budget was implemented at IFW. Since 2003, IFW has used a system of cost-performance assessment (*Kosten-Leistungs-Rechnung, KLR*). It comprises scientific output parameters like publication figures, invited talks, external funding, and patents for each of the five research areas. At some stage, IFW’s Executive Board should examine whether changes in IFW’s scientific structure (see Chapter 2) have any implications for the design of the programme budget that require action.

Quality management by the Scientific Advisory Board and Supervisory Board

The Scientific Advisory Board (SAB) fulfils its tasks extremely carefully and conscientiously. Once a year, it conducts an intensive audit of approx. a third of IFW’s research programme. The Board is also very involved in advising the institute on its overall strategic development. With regard to IFW’s leadership crisis, the SAB consistently supported both the institute's leadership and the Board of Trustees with great care and competence.

According to IFW's statutes, members of the SAB can be re-elected a number of times. In the past, use has sometimes been made of this option. In the Leibniz Association it is usual that members of the SAB may not be elected for more than two periods of office, whereby the latter may be extended from three to four years.

The Board of Trustees also supports the institute very well. It was good that, together with the SAB, it responded so promptly to the problems at management level.

Implementation of recommendations from the last external evaluation

The following recommendations from the last evaluation (see Status Report, p. A-21 ff.) are still relevant:

Recommendation 3: *IFW members should intensify their guest visits at other institutions:*

IFW hosts a very large number of visiting researchers. In the last few years, IFW scientists have gone on more research visits to other institutions than was previously the case, but the figures are still comparatively low (see Chapter 4).

Recommendation 4: *IFW should increase the revenue from licensing/* Recommendation 5: *IFW should increase revenue from direct industry cooperation:* The income from licences has only increased insignificantly since the last evaluation (see Chapter 3 for the evaluation of patents policy).

Recommendation 6: *Increase the portion of women in leading scientific positions:* It is pleasing that, since 2007, two Emmy Noether Junior Research Groups have been established at the institute, which are headed by highly-qualified, young female researchers. IFW must under all circumstances perpetuate this development and intensify its efforts to recruit excellent women scientists (see Chapter 5).

Recommendation 7: *The budget should be made more flexible wherever possible, particularly with regard to the staff appointment scheme (*Stellenplan*). It should also be made possible to use annual funds for multiple years:* IFW is still bound by a staff appointment scheme (*Stellenplan*). It is welcomed that a change is expected in the next programme budget in 2015/2016. In addition to the general management principles, funds for investments and operation are transferable unless otherwise stipulated in fund planning.

Recommendation 8: *IFW should make more use of its programme budget as a flexible steering tool for its scientific development:* A programme budget has been implemented at IFW, but the institute should still make more use of it as a steering tool for its scientific development (see Chapter 6).

Appendix

1. Review Board

Chair (Member of the Leibniz Senate Evaluation Committee)

Dagmar **Gerthsen**	Laboratory for Electron Microscopy, Karlsruhe Institute of Technology, Germany

Deputy Chair (Member of the Leibniz Senate Evaluation Committee)

Norbert **Suttorp**	Campus Virchow-Klinikum, Medizinische Klinik mit Schwerpunkt Infektiologie und Pneumologie, Berlin, Germany

Reviewers

Andreas **Berger**	CIC nanoGUNE Consolider, Donostia – San Sebastian, Spain
Lesley **Cohen**	Blackett Laboratory, Imperial College London, UK
Andrea **Damascelli**	Department of Physics & Astronomy, University of British Columbia, Vancouver, Canada
Klaus-Peter **Dinse**	Department of Physics, Freie Universität Berlin, Germany
David **Larbalestier**	Applied Superconductivity Center, National High Magnetic Field Laboratory, Florida State University, USA
Peter **Lodahl**	Niels Bohr Institute, University of Copenhagen, Denmark
Kurt **Schönhammer**	Institute for Theoretical Physics, Georg-August-Universität Göttingen, Germany
Jörg **Schmalian**	Institute for Theory of Condensed Matter, Institute for Solid State Physics, Karlsruhe Institute of Technology, Germany
Cynthia A. **Volkert**	Institute of Materials Physics, University of Göttingen, Germany
Achim **Wixforth**	Institute of Physics, University of Augsburg, Germany
Margret **Wohlfahrt-Mehrens**	Centre for Solar Energy and Hydrogen Research Baden-Württemberg, Ulm, Germany

Representative of the Federal Government (Member of the Leibniz Senate Evaluation Committee)

Ingo **Höllein**	Federal Ministry of Education and Research, Bonn, Germany

Representative of the Länder *Governments (Member of the Leibniz Senate Evaluation Committee)*

Martin **Dube**	Ministry for Education, Science and Culture of Mecklenburg-Vorpommern, Schwerin

2. Guests

Representative of the relevant Federal government department

Herbert **Zeisel**	Federal Ministry of Education and Research, Bonn, Germany

Representative of the relevant Land *government department*

Jörg **Geiger**	Saxon State Ministry for Higher Education, Research and the Arts, Dresden, Germany

Representative of the Scientific Advisory Board

Maria-Roser **Valenti**	Institute for Theoretical Physics, Goethe University Frankfurt am Main, Germany

Representative of the Leibniz Association

Matthias **Steinmetz**	Leibniz Institute for Astrophysics, Potsdam, Germany

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

Eckhard **Beyer**	Fraunhofer-Institute for Material and Beam Technology IWS, Dresden, Germany
Thomas **Geßner**	Department of Electrical Engineering and Information Technology, Technische Universität Chemnitz, Germany
Gerhard **Rödel**	Vice-Rector of Research, Technische Universität Dresden, Germany

17 December 2014

Annex C: Statement of the Institution on the Evaluation Report

Leibniz Institute for Solid State and Materials Research (IFW) Dresden

General comments:

The IFW thanks the evaluation board and those involved from the Leibniz-Gemeinschaft for their engagement in the course of the evaluation process.

We are very pleased about the general statement of the board that IFW fulfils its “mission extremely successfully”, which will additionally motivate everyone involved to address the board's recommendations to further enhance the overall performance of the IFW.

Different to the previous evaluation report, the 13 subdivisions of IFW have been evaluated and rated in detail, most of them “very good to excellent”. The IFW appreciates the individual comments to the subdivisions which are very helpful.

Comments to specific recommendations:

The new research program of IFW was found to be convincing by the board. It should be pointed out that this research program was developed by the four presently active institute directors in a concerted effort. The research program is supported by leading scientists of all IFW institutes. We are pleased to read that the scientific ideas and approaches for continuing IFW's development are supported by the board. After the formal appointment of the new director of the IMW, it will be the responsibility of the new scientific director to coordinate and lead the implementation of the new research program in a collaborative and transparent process.

It is in the very interest of the IFW to convert the present situation with a temporary scientific director into a management structure with a long-term stability. The IFW will support the scientific advisory board and the supervisory board in their endeavor to address this issue.

Technology transfer to industry remains a central mandate of the IFW. The recommendation of the evaluation board to increase the proportion of project funding from industry is certainly one way to achieve this goal. IFW has already started to assess the internal instruments which favor industrial cooperation. Restructuring IFW’s patent strategy, giving more weight to a balance of income and cost will be an additional step.

The recommendation to increase the proportion of women at all levels is taken very seriously and will be pursued rigorously.

The IFW will strive to offer to all its PhD-students the possibility to participate in a structured PhD program. At the same time we will analyze the length of doctoral studies in order to keep them well below 4 years.

We agree to the recommendation that it would be desirable if more scientists spend longer periods of time at other institutions. Appropriate opportunities will be recommended by the leading scientists more insistently.

The recommendations concerning the flexibility of budget and the staff appointment scheme are addressed to the supervising ministry – the IFW would applaud in this regard any facilitations, which have already proven their merits in Leibniz institutes in other federal states and/or other research institutes.