PREFACE

This report is part of a series documenting the scientific activities and achievements of the Max-Planck-Institut für Eisenforschung GmbH (MPIE) in 2011 and 2012. For evaluation purposes some main trends are described over the past 6 years.

MPIE conducts basic research on structural materials, specifically steels, for nearly one century, considering their complex chemical-physical synthesis, characterisation and properties, as well as their use in systemic components. Projects are characterized by a highly interdisciplinary approach including close interfacing between experiment and theory.

Through its research on structural materials the Institute plays a central role in enabling progress in the fields of mobility (e.g. steels and soft magnets for light weight hybrid vehicles), energy (e.g. efficiency of thermal power conversion through better high temperature alloys), transport (e.g. Ni-base alloys for plane turbines), infrastructure (e.g. steels for large infrastructures, e.g. wind turbines and chemical plants) and safety (e.g. nanostructured bainitic steels for gas pipelines). A close match between knowledge-oriented and pre-competitive basic research on the one hand and commercial relevance on the other hand is an important cornerstone of this concept. With its system-oriented research agenda and its 50% institutional co-sponsoring by industry, the Institute is a unique example of public private partnership both for the Max Planck Society and for the European industry.

The departments jointly pursue a number of cross-disciplinary research branches covering Materials Design (simulation, synthesis, combinatorial materials design), Materials Analysis (structure, chemistry, defects), Materials Processing (thermomechanical treatment, forming, joining, coating), and Materials Properties (mechanical, stability, function). In many of these areas the institute holds a position of international scientific leadership, particularly in multiscale materials modeling; surface science; metallurgical alloy design; and characterization from atomic to macroscopic scales of complex engineering materials.

Profound strengthening of the institute's scientific profile is also achieved by the close cooperation with R. Kirchheim (materials physics and atom scale characterization; University of Göttingen) who is an external scientific member of the Max-Planck Society and with G. Eggeler (high temperature alloys and energy-related materials; Ruhr-University Bochum) who is a fellow of the Max-Planck Society. With both colleagues a number of joint projects are being pursued (e.g. exploring the limits of strength in Fe−C systems; hydrogen-propelled materials and systems; defectant theory; creep of superalloys; atomic scale analysis of interfaces in superalloys).

The institute hosts about 270 people, the majority being scientists. As only 120 employees are funded by the basic budget provided by the shareholders of the institute, nearly 150 additional scientists work at the institute supported by extramural sources. This strong contribution of third-party funds and its balance between fundamental and applied science gives the institute a singular position within the Max-Planck Society.

The increasing number of co-operations with key industry partners has provided further extramural momentum to the dynamic growth of the institute during the past two years. Besides the well established links to material companies in the fields of structural alloy design (bulk and surface), advanced characterization methods in steel development, surface functionalization, and computational materials science, new exiting industrial co-operations are currently being developed in a number of novel fields: These new project directions are particularly valuable for the institute's further development from a materials-oriented laboratory towards a system-driven institute that deals with complex materials in a more holistic context of including complicated engineering systems, loading, and environmental conditions into advanced materials science and engineering projects. New areas of growth including strong interactions with industry are in the fields of steels and related materials for automotive hybrid- and electro-mobility, energy conversion and storage, renewable energy, health, hydrogen-based industries, and computational materials science.

This report is structured into IV parts:

- *Part I* presents the organization of the institute including a short section on recent scientific developments, new scientific groups, large network activities, and new scientific laboratories at the institute.

- *Parts II* and *III* cover the research activities of the institute. Part II provides a description of the scientific activities in the departments and Part III contains selected short papers which summarise major recent scientific achievements in the four areas of common interest of the institute ‘New Structural Materials’, ‘Microstructure-Related Materials Properties’, ‘Stability of Surfaces and Interfaces’, and ‘Scale-Bridging Simulation of Materials’.

- *Part IV* summarises some statistically relevant information about the institute.

Dierk Raabe, Chairman of the executive board
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