Preface

Materials testing experienced significant changes during the recent years, in particular with respect to more product-oriented testing, transfer of realistic coupled loading conditions from real products into the laboratories and vice-versa, online monitoring techniques and clarification of failure phenomena.

At the same time, substantial advancements have been achieved in complex analyzing technologies, in particular utilizing photons, neutrons and electron scattering. The rapid progress in engineering of respective beam sources and their configuration as well as of ultrahigh-speed beam and areal detectors provides most powerful tools to gain in-depth insight into complex materials behavior and degradation phenomena. Meanwhile, numerous measuring devices are available at large-scale research facilities operating all over the world with modern photon and neutron sources. In the last years, temporal and even spatial high-resolution in situ analyses have gained paramount importance, since the brilliant beam sources allow direct detection and quantitative ascertainment, respectively, of transient processes.

Especially, the diffraction processes, small-angle scattering and X-ray or neutron radiography can be regarded as most suitable analysis methods for examining diversified non-equilibrium processes, quasi real-time phase transformation processes, crack formation and propagation processes or stress/strain build-up in advanced engineering materials. Modern diffraction experiments provide exclusive statements about materials behavior with nano-scale precision.

As a particular feature and in contrast to conventional laboratory X-ray sources with comparatively low penetration depths and low beam flow densities, high energy synchrotron X-rays or neutron radiation enable analyses of the material volume. Although high-energy radiation is often limited to short measuring cycles, modern beam sources meanwhile permit complex in situ investigations of metallic materials during real heating and cooling cycles. This particularly widens the perspectives to fully understand the material kinetics during real welding processes or thermo-mechanical stress evolution during cooling.

With this background, an international workshop was initiated on 1st and 2nd September 2009 in Berlin at the Federal Institute for Materials Research and

Participants in the 1st International Workshop "In-situ Studies with Photons, Neutrons and Electron Scattering" held on 1st and 2nd September 2009 at BAM Federal Institute for Materials Research and Testing

Testing (BAM) in cooperation with the Osaka University, the Brazil Synchrotron Light National Laboratory and the Helmholtz Centre Berlin (HZB). Most prominent experts from all over the world presented their cutting edge research on in situ diffraction analyses of non-equilibrium processes, transformation kinetics and residual stress evolution of different metallic materials with a special emphasis on welding.

In the detailed discussions during the two days, the theoretical and experimental viewpoints have been exchanged, resulting finally for all participants in a closer insight into the different synchrotron and neutron diffraction techniques as well as into innovative microscopy techniques. The workshop immediately gained significant interest in the total materials science and engineering community.

The present book now contains the scientifically peer-reviewed individual contributions presented at the workshop. Accordingly, it is divided into the topics:

– In Situ Welding Experiments
– Crack Growth and Hot Cracking Phenomena
– Phase Detection and Quantification
– Stress/Strain Build-Up.

In total, the various contributions provide a comprehensive overview of the outstanding potential of in situ diffraction experiments using photon, neutrons and electron scattering in exploring not yet fully understood materials behavior and failure phenomena. It also summarizes some huge steps forward towards higher beam quality, measurement and evaluation methods. Finally, it shows the demand for intensive scientific exchange about such subjects in the future and the experts recommended building a research network for in situ scattering studies of advanced materials processing which allows the various research groups to even more intensively share their knowledge and might include also additional materials science and engineering research topics.

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