
Preface of Series by the Editor-in-Chief

This book titled *High-Temperature Measurements of Materials* is the 11th volume in the series “Advances in Materials Research” edited by Professors Hiroyuki Fukuyama and Yoshio Waseda. The book is composed of nine chapters, the contents of which try to solve the currently important basic problems in high-temperature melts from scientific basics to real application fields related to industrial problems. The contents of this present volume are expected to contribute to solving the most important problem of sustainability of the global society by applying recent high-level scientific and engineering researches in materials science. Recent important contributions from large scale experimental facilities from over the world are collected and explained in detail in this book, where we can now measure clearly the important behaviors of high-temperature melts which have never been observed by traditional experimental techniques. This book also introduces recent advancements in computer simulations, which have become very effective not only in explaining experimentally observed phenomena but also in predicting materials properties and processes which are difficult to be measured for the materials under high-temperature environments.

As the series editor, I thank Dr. Claus Ascheron of Springer-Verlag, who always has interest in and kindly takes care of our research activity to encourage publication in this series of books.

Sendai, July 2008

Yoshiyuki Kawazoe

Preface

A variety of industries – information technology, aerospace, automobile, and basic and new materials manufacturing – need technological innovations, which bring high-value-added and high-quality products at low cost not only because of global competition, but also because of the perspective of environmental consciousness and regulation. Thermophysical properties of high-temperature melts are indispensable for numerical simulations of material processes such as semiconductor and optical crystal growth of the melt, and casting of super-high-temperature alloys for jet-engine turbine blades, in addition to welding in automobile manufacturing. Recent developments in process modeling provide 3D unsteady analysis of melt convection, temperature, and heat flux distribution, which enables us to predict product quality. In fact, 3D process visualization using computer modeling helps us to understand complicated phenomena occurring in the melt and to control the process.

Accurate data are necessary to improve the modeling, which cost-effectively engenders high-quality products. However, crucial obstacles render measurements of thermophysical properties difficult at elevated temperatures because of high chemical reactivity and fluidity of melts. Substantial and persistent challenges have been made to ascertain the precise thermophysical properties of high-temperature melts. This book describes the new techniques and latest developments in the measurements of atomic structure, density, surface tension, viscosity, heat capacity, thermal and mass diffusivity, thermal conductivity, emissivity, and electrical conductivity of high-temperature melts.

In addition to up-to-date improvements in conventional techniques, some new attempts are introduced to open a new scientific field, that is, physics of high-temperature melts. Space-related organizations such as Japan Aerospace Exploration Agency (JAXA) and German Aerospace Center (DLR) demonstrate the importance of noncontact measurements and microgravity environments. Recent progress in levitation techniques enables high-precision measurements of various properties of stable and deeply undercooled metallic melts. An electrostatic levitation apparatus is specially designed not only

VIII Preface

to measure thermophysical properties but also to study the short-range order of metallic melts in combination with a synchrotron radiation facility: SPring-8 (Japan Synchrotron Radiation Research Institute, JASRI). A noncontact measurement of thermal conductivity was developed using an electromagnetic levitator incorporating a superconducting magnet (High Field Laboratory for Superconducting Materials, Institute for Materials Research, Tohoku University). An electromagnetically levitated droplet behaves as a hard sphere in a static magnetic field. The oscillation and convection of the droplet are suppressed because of the Lorentz force, which enables measurement of its true thermal conductivity using modulation laser calorimetry. Utilization of microgravity conditions provides an ideal environment without a fluid flow driven by buoyancy force. Diffusion coefficients of metallic melts have been determined using the shear cell technique under microgravity using a sounding rocket.

As described earlier, this book is a unique compilation of information related to recent advances in high-temperature measurements and thermophysical properties data. The editors earnestly hope that this book is a useful guide for the scientists and engineers who are working in the field of materials science and processing, and that it is attractive to students interested in the physics of high-temperature melts.

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