

Vaporization and Thermodynamics of Glass-Forming Oxide Melts: Mass Spectrometric Study and Modeling

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Abstract

Information on the vaporization processes and thermodynamic properties of glass-forming oxide melts in the systems $\text{MgO-B}_2\text{O}_3\text{-SiO}_2$, $\text{CaO-B}_2\text{O}_3\text{-SiO}_2$, $\text{SrO-B}_2\text{O}_3\text{-SiO}_2$, $\text{BaO-B}_2\text{O}_3\text{-SiO}_2$, $\text{PbO-B}_2\text{O}_3\text{-SiO}_2$, $\text{CdO-B}_2\text{O}_3\text{-SiO}_2$, $\text{ZnO-B}_2\text{O}_3\text{-SiO}_2$, $\text{Bi}_2\text{O}_3\text{-B}_2\text{O}_3\text{-SiO}_2$ and $\text{Bi}_2\text{O}_3\text{-GeO}_2\text{-SiO}_2$ together with the earlier obtained data is discussed. These data were obtained by high-temperature mass spectrometric method. Various types of vapor species were found over oxide systems studied such as the associated, dissociated and polymerized products of vaporization. The regularities of the vaporization of the binary and multicomponent glass-forming oxide melts were illustrated and discussed from the point of view of the acid-base concept. Results on determination of thermodynamic functions in oxide systems were considered taking into account the main requirements for the confirmation of their reliability. The generalized lattice theory of associated solutions was used for the calculation of thermodynamic properties of the ternary silicate melts studied. Using this approach the different levels of deviations from the ideality in the melts under investigation were clarified. The relative numbers of bonds of various types formed in the melts considered were also calculated based on the generalized lattice theory of associated solutions.

Keywords

Glass-Forming Oxide Melts, Thermodynamics, Vaporization, High Temperature Mass Spectrometry

1. Introduction

Development of the advanced glass materials requires the reliable information on vaporization processes and thermodynamic properties of glass-forming melts. This paper presents the review on the recent data obtained by Knudsen effusion mass spectrometric method on high temperature behavior of glass-forming oxide melts in the systems $\text{MgO-B}_2\text{O}_3\text{-SiO}_2$, $\text{CaO-B}_2\text{O}_3\text{-SiO}_2$, $\text{SrO-B}_2\text{O}_3\text{-SiO}_2$, $\text{BaO-B}_2\text{O}_3\text{-SiO}_2$, $\text{PbO-B}_2\text{O}_3\text{-SiO}_2$, $\text{CdO-B}_2\text{O}_3\text{-SiO}_2$, $\text{ZnO-B}_2\text{O}_3\text{-SiO}_2$, $\text{Bi}_2\text{O}_3\text{-B}_2\text{O}_3\text{-SiO}_2$ and $\text{Bi}_2\text{O}_3\text{-GeO}_2\text{-SiO}_2$. The systems under study have the wide range of practical applications in the production of glasses, enamels, glaziers and ceramics as well as in the various high tem-

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Mass Spectrometric Study of the Vaporization of Oxide Systems V. L. Stolyarova, G. A. Semenov, 1994-10-25 Classifies and discusses available information on vaporization processes in oxide systems obtained by the high temperature mass spectrometric technique taking into account its practical application in various fields Includes the principles and experimental peculiarities of diverse types of compounds Bibliography of Mass Spectroscopy Literature for 1970 ,1972

Journal of Research of the National Institute of Standards and Technology ,1990 Reports NIST research and development in the physical and engineering sciences in which the Institute is active These include physics chemistry engineering mathematics and computer sciences Emphasis on measurement methodology and the basic technology underlying standardization Scientific and Technical Aerospace Reports ,1978-04 **NASA Technical Note** United States. National Aeronautics and Space Administration,1972 **High Temperature Gas-Solid Reactions in Earth and Planetary**

Processes Penelope King, Bruce Fegley, Terry Seward, 2018-12-03 High temperature gas solid reactions are ubiquitous on planetary bodies distributing chemical elements over a range of geologic settings and temperatures This volume reviews the critical role gas solid reactions play in early solar system formation volcanism metamorphism and industrial processes The field evidence experimental and theoretical approaches for examining gas solid reaction are presented building on advances in fields outside of Earth Sciences Computational chemistry techniques are used to probe the nature of molecular clusters and solvation in volcanic vapors and mineral gas reaction mechanisms Specialised analytical methods for characterising solid reaction products are included since these reactions commonly form thin or dispersed films and metastable minerals Finally the volume contains rich field examples laboratory experiments and thermodynamic modelling and kinetics of gas solid reactions on Earth Venus and beyond *Advances in Mass Spectrometry, Volume 12* P.G. Kistemaker, N.M.M.

Nibbering, 2012-12-02 These proceedings containing the texts of the invited lectures cover all aspects of mass spectrometry including theory fundamental studies applications and instrumentation Emphasis is placed on recent developments A complete listing of the posters is included **Bibliography on the High Temperature Chemistry and Physics of**

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Superintendent of Documents, 1976 *Advances in Mass Spectrometry* R. M. Elliott, 2013-10-22 *Advances in Mass Spectrometry Volume 2* documents the proceedings of a conference on mass spectrometry held in Oxford in September 1961 This compilation is categorized into six major topics mass spectrometry in research mass spectrometry of inorganic compounds instruments and techniques theory and correlation of mass spectra mass spectra and analysis and ionization and dissociation Under these major topics parts of the papers discussed include field ionization mass spectroscopy initial kinetic energy discrimination effects in crossed field ion sources mass spectrometric study of CaO and Ta and spark source mass spectrometry as an analytical technique The book also covers discussions on initial energy of hydrocarbon fragment ions

determination of the structure of alkaloids by mass spectrometry and application of a time of flight mass spectrometer to the examination of ion molecule interactions This volume is a useful reference to students and researchers conducting work on mass spectrometry *Nuclear Science Abstracts* ,1974 **TID.** ,1972 *NASA Scientific and Technical Reports* United States. National Aeronautics and Space Administration Scientific and Technical Information Division,1967 Proceedings of the Congress: Glass structure ... Optical and optoelectronic devices Alicia Durán,José María Fernández Navarro,1992

Technical Abstract Bulletin , *U.S. Government Research Reports* ,1964 Thoria-based Nuclear Fuels Dasarathi Das,S. R. Bharadwaj,2013-12-24 This book presents the state of the art on thermophysical and thermochemical properties fabrication methodologies irradiation behaviours fuel reprocessing procedures and aspects of waste management for oxide fuels in general and for thoria based fuels in particular The book covers all the essential features involved in the development of and working with nuclear technology With the help of key databases many of which were created by the authors information is presented in the form of tables figures schematic diagrams and flow sheets and photographs This information will be useful for scientists and engineers working in the nuclear field particularly for design and simulation and for establishing the technology One special feature is the inclusion of the latest information on thoria based fuels especially on the use of thorium in power generation as it has less proliferation potential for nuclear weapons Given its natural abundance thorium offers a future alternative to uranium fuels in nuclear technology In closing the latest information on conventional uranium and plutonium fuels is also provided *Encyclopedia of Spectroscopy and Spectrometry* ,2010-04-09 The Second Edition of the Encyclopedia of Spectroscopy and Spectrometry pulls key information into a single source for quick access to answers and or in depth examination of topics SPEC 2 covers theory methods and applications for researchers students and professionals combining proven techniques and new insights for comprehensive coverage of the field The content is available in print and online via ScienceDirect the latter of which offers optimal flexibility accessibility and usability through anytime anywhere access for multiple users and superior search functionality No other work gives analytical and physical biochemists such unprecedented access to the literature With 30% new content SPEC 2 maintains the authoritative balanced coverage of the original work while also breaking new ground in spectroscopic research Incorporates more than 150 color figures 5 000 references and 300 articles 30% of which are new for a thorough examination of the field Highlights new research and promotes innovation in applied areas ranging from food science and forensics to biomedicine and health Features a new co editor David Koppenaal of Pacific Northwest National Laboratory Washington USA whose work in atomic mass spectrometry has been recognized internationally *Materials Processing Fundamentals 2019* Guillaume Lambotte,Jonghyun Lee,Antoine Allanore,Samuel Wagstaff,2019-02-09 This book includes contributions from the Materials Processing Fundamentals Symposium held at the TMS 2019 Annual Meeting Exhibition in San Antonio Texas This volume includes contributions on the physical and numerical modeling of materials processing and covers a range of metals and

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