TABLE OF CONTENTS

Session 7

Session 7

THERMODYNAMICS AND CRYSTALLIZATION KINETICS OF Al-BASED AMORPHOUS METAL ALLOYS

Gary J. Shiflet and M.C. Gao
University of Virginia, USA
E-mail: gjs@virginia.edu

Phase equilibria studies were applied in conjunction with several structural experimental techniques, including XRD, conventional TEM and quantitative analytical TEM to generate a self consistent thermodynamic data-base for Al-Ni-Gd alloys. Using the CALPHAD method, driving forces can be calculated and compared to experimental results. We find that Gibbs free energy can be used to help direct optimum compositions, but only in a restrictive fashion. Optimal control of the devitrification path in this class of alloys will be discussed. The attractive properties and many pitfalls associated with the possible use of this alloy for structural components will be presented.

STABILITY AND NUCLEATION BEHAVIOR OF GLASS-FORMING Pd-Cu-Ni-P ALLOY WITH A CRITICAL COOLING RATE OF 0.067 K/S

Nobuyuki Nishiyama
Inoue Superliquid Glass Project, ERATO, JST, Japan
E-mail: nisiyama@sendai.jst.go.jp
Akihisa Inoue, IMR, Tohoku University

$Pd_{40}Cu_{30}Ni_{10}P_{20}$ alloy has an extremely large glass forming ability (GFA) and a low critical cooling rate for glass formation of 0.10 K/s. This exceptional high thermal stability and retarded crystallization kinetics enables us to investigate the nature of the undercooled melt i.e. thermodynamics, viscosity, thermal expansion, elastic modulus and other properties. If the alloy having larger GFA could be found, it will give us further understanding of a reason for the large GFA. The $Pd_{40}Cu_{30}Ni_{10}P_{20}$ alloy appears to show a slightly off-eutectic composition. It might be possible to enhance the GFA by searching a Pd-Cu-Ni-P alloy with a just eutectic composition. Therefore the stability and GFA for the alloys with compositions around the $Pd_{40}Cu_{30}Ni_{10}P_{20}$ alloy are examined. As a result, it is found that a new alloy composition with the lowest Rc of 0.067 K/s. The new alloy has 1.5 times longer incubation time for crystallization than conventional one. We will report a different nucleation mechanism between new and conventional alloy. Based on the obtained results, the reason for the exceptional GFA will be also discussed.

FREQUENCY DEPENDENCE MODULUS OF $Pd_{40}Ni_{10}Cu_{30}P_{20}$ AMORPHOUS ALLOY **AROUND THE GLASS TRANSITION BY DYNAMIC MECHANICAL ANALYSIS**

M.L. Lee, Y. Li, Y.P. Feng
Singapore-MIT Alliance, Advanced Materials for Micro- and Nano- Systems Programmes,
National University of Singapore,
E-mail: smap9046@nus.edu.sg
C.W. Carter, Massachusetts Institute of Technology, USA

Dynamic Mechanical Analyzer (DMA) was used to study the frequency dependence of storage and loss modulus of amorphous $Pd_{40}Ni_{10}Cu_{30}P_{20}$ alloy over a broad frequency range around its glass transition temperature. The amorphous samples were subjected to two testing conditions: constant frequency with continuous heating and isothermal with frequency sweep. The storage modulus E` exhibited a sigmoidal change from about 90 GPa to a low value of about 0 GPa over the glass transition region. The loss Modulus E`` was characterized by an asymmetrical peak with a smaller slope at the low temperature side than at the high temperature side upon heating. These changes in modulus were associated with mechanical relaxation due to atomic motion. Similar results were also obtained under isothermal condition. The Kohrausch-Williams-Watts function was used to fit the data obtained under the isothermal condition. The peak frequencies obtained were then fitted to the Vogel-Fulcher-Tamman and the scaling law equation.

INVESTIGATIONS OF MECHANICALLY ALLOYED Ni-Zr-Ti-Si AMORPHOUS ALLOYS WITH SIGNIFICANT SUPERCOOLED REGIONS

Chung-Kwei Lin
Department of Materials Science, Feng-Chia University, Taiwan
E-mail: cklin@fcu.edu.tw
Rong-Ruey Jeng and Ling-Yi Wang
Chung-Shan Institute of Science& Technology, Taiwan
I-Kuan Cheng and Pee-Yew Lee
National Taiwan Ocean University, Taiwan

This study examined the amorphization behavior of $Ni_{57}Zr_{20}Ti_{23-x}Si_x$ (x=0, 1, 3) alloy powders synthesized by mechanical alloying technique. According to the results, after 5 hours of milling, the mechanically alloyed powders were amorphous at compositions $Ni_{57}Zr_{20}Ti_{23-x}Si_x$ (x=0, 1, 3). The thermal stability of the $Ni_{57}Zr_{20}Ti_{23-x}Si_x$ amorphous powders was investigated by differential scanning calorimeter (DSC). As the results demonstrated, the amorphous powders were found to exhibit a large supercooled liquid region before crystallization. The amorphization behavior of $Ni_{57}Zr_{20}Ti_{20}Si_3$ was examined in details. The conventional X-ray diffraction and synchrotron EXAFS results confirm that the fully amorphous powders formed after 5 hours of milling. A kinetically modified thermodynamic phase transformation process was observed for the glass transition behavior in the $Ni_{57}Zr_{20}Ti_{20}Si_3$ amorphous powder.

ON A HARMFULL EFFECT OF ZrB_2 COMPOUND ON BULK GLASS FORMATION IN Fe-Zr-B BASED ALLOYS

M.I. PETRZHIK and V.V. MOLOKANOV
A.A. Baikov Institute of Metallurgy & Materials Science, Russia
E-mail: petrzhik@ultra.imet.ac.ru
Jun SHEN and Jianfei SUN, Harbin Institute of Technology, China
T.A. SVIRIDOVA, Moscow State Institute for Steel and Alloys, Rusia

It is known, that the best ferrous glass forming alloys belong to Fe-Zr-B alloy system [1]. In this paper we discuss conditions of formation of a specific 3D-distribution of amorphous and crystalline quenching products in bulk $Fe_{61}Co_7Zr_{10}Mo_5W_2B_{15}$ rods and melt spun ribbons. The problem is that both Zr and B are chemically active elements and easily form in melt ZrB_2 refractory compound. Its portion depends on quenching temperature and technique used for sample production [2]. Bonding of zirconium and boron in melt changes its composition. As a result a portion of amorphous phase in quenched samples decrease and crystallization goes at two stages. The lower is cooling rate, or the more is a number of re-melting, the more is a portion of ZrB_2 because the phase is stable and presents at phase diagram. If the phase has been appeared in arc melted ingots, then it inherits in RQ rods as well as in melt spun ribbons and prevents to bulk glass formation. Some methods to prevent a harmful effect of ZrB_2 compound formation and obtain bulk ferrous metallic glasses are discussed.