THE DECOMPOSITION OF $Pd_{40}Ni_{40}P_{20}$ BULK METALLIC GLASS

M.K. Miller, K.L. More, T.D. Shen*, and R.B. Schwarz*

Microscopy, Microanalysis, Microstructures Group, Metals and Ceramics Division,
Oak Ridge National Laboratory, Oak Ridge, TN 37831-6136
*Structure/Properties Relations Group, Materials Science and Technology Division,
MS G755, Los Alamos National Laboratory, Los Alamos, NM 87545

A systematic study has been conducted on the decomposition of a $Pd_{40}Ni_{40}P_{20}$ bulk metallic glass during isothermal annealing between the glass transition temperature and the onset of crystallization temperature. The microstructure was characterized with a combination of techniques including differential scanning calorimetry (DSC), x-ray diffraction (XRD), atom probe tomography (APT) and high resolution transmission electron microscopy (HREM).

The $Pd_{40}Ni_{40}P_{20}$ alloy was characterized in the as-produced condition, after a pre-annealed of 14 h at 260°C, and after isothermally aging at 340°C for various times up to 1280 min. The isothermal aging temperature is approximately 40°C above the glass-transition temperature, T_g, and 60°C below the onset of crystallization temperature, T_x. Atom probe tomography characterizations were performed with the Oak Ridge National Laboratory local electrode atom probe.

Two endothermic peaks were observed in the differential scanning calorimetry curves of the isothermally aged samples. The first peak, at 330°C, was largest in the pre-annealed sample and disappeared after 10 min. aging at 340°C. The second peak appeared after 20 min. aging and disappeared after 320 min. aging. The corresponding XRD data did not showed any Bragg peaks that could indicate the formation of crystalline embryos. However, distinct Bragg peaks indicating crystallization were seen in the XRD data after 640 min. aging. Atom probe tomography was used to study the fine scale decomposition. For all heat treatments up to 40 min. at 340°C, no significant decomposition was observed in atom maps or narrow (2 x 2 nm) cross section concentration profiles. However, isoconcentration surfaces revealed some fine scale, very low amplitude inhomogeneities in the solute distribution which correlates with the appearance of the second peak in the DSC signal. Atom maps and narrow cross section concentration profiles reveal fine scale inhomogeneities in the solute distribution after annealing for 80 min. at 340°C. Phosphorus isoconcentration surface shows evidence of an extremely fine scale percolated, isotropic, two phase microstructure. Fine scale cuboidal particles were evident in the atom maps, concentration profiles, concentration slices and iso-concentration surfaces after annealing for 320 min at 340°C. The number density of cuboidal particles increased with annealing time. Some impingement of the cuboidal precipitates was observed at the later annealing times.

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