Structure and Stability of a Splat-Cooled Fe-P-C Alloy

Structural Stability of Amorphous Metals

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Effects of annealing and plastic deformation on structure of several amorphous metals (Pd-Si, Fe-Si-B, Ni-Si-B, Co-Si-B, etc.) were examined by using dark-field electron microscopy, x-ray and electron diffraction, hardness, specific gravity and electrical resistivity. In T-T-T diagrams, distinct differences in transformation sequence were observed beyond and below the critical temperature. Above this temperature, crystallization proceeds through two metastable phases and finally to the stable phase by nucleation and growth mechanisms. Below the temperature, however, progressive aging gradually changes the structure through two stages; the first stage is due to release of internal strain in the rapidly quenched specimens and the second stage due to transformation from amorphous to single phase with the same structure as the major element. Plastic deformation at room temperature produces a much more disordered atomic structure than is present in the as-quenched state perhaps by introducing additional irregularities.

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The structure and the stability of a splat-cooled iron-based alloy (80Fe-13P-7C) were investigated by using electron and X-ray diffraction methods, high voltage electron microscopy and field ion microscopy. No appreciable change occurred in the transmission electron diffraction pattern as well as in the transmission electron microscope image by the irradiation of electrons being accelerated at any voltage in the range of 100 kV–1000 kV up to the total dose of 10^{23} electrons/cm^2. However, when the specimen was heated in-situ up to 200°C under irradiation, the splitting of the second halo ring disappeared already at the total dose of 2×10^{22} electrons/cm^2, whereas such change did not occur in the unirradiated region of the specimen. Furthermore, crystallization was retarded in the irradiated region. Pole figure determination indicates no development of preferred orientation in the crystallization process of the splat-cooled alloy and also the cold rolled sheet of the alloy. The field ion micrographs obtained with the splat-cooled alloy tips were far different from the imaging ring patterns which were observed with the crystallized one and the data which support positively the existence of the microcrystalline phase have not been obtained so far (color superposition method is now being applied). The observations by dark field electron microscopy and lattice fringe electron microscopy made in parallel to FIM observation so far support the FIM observation.