THE MECHANICAL PROPERTIES OF PALLADIUM 20 AT. % SILICON ALLOY QUENCHED FROM THE LIQUID STATE

by

T. Masumoto and R. Maddin

We have examined the elastic and plastic behavior of a noncrystalline palladium 20 atomic percent silicon alloy and the changes that occur in these properties on crystallization during and after heating at various temperatures. The mechanical properties, such as yield and fracture strength, Young's modulus and elongation, of the noncrystalline and the metastable and stable crystalline phases were investigated using filaments of the alloy. The noncrystalline specimens were obtained by means of a newly developed filamentary casting apparatus yielding filaments between 15 and 50 microns in thickness and between 0.15 and 0.5 mm. in width. The process of transformation to the crystalline state was examined using electrical resistivity, x-ray and electron diffraction, electron microscopy and mechanical properties. The mechanical tests were performed over a temperature region between -195°C and 500°C and through a range of strain rates from 0.03 to 0.005 per min. The noncrystalline structure was stable below 300°C; on heating at a temperature of 300°C or above, it changed into metastable structures; first, to a face-centered cubic structure with a lattice constant of about 4.0 Å, then to an ordered face-centered cubic structure with a lattice constant equal to 15.5 Å and finally into its stable orthorhombic structure, i.e., Pd_3Si. The process of crystallization (the phase transformation) was examined in a hot stage in the electron microscope.

The noncrystalline phase shows a brittle behavior with relatively high strength of about 1.2×10^5 psi yield strength, 2×10^5 psi fracture strength and with about 10×10^6 psi Young's modulus but 0.1% elongation. As crystallization proceeded, its strength properties were lower but its Young's modulus increased. The temperature dependence of the mechanical properties was also measured for both the noncrystalline and the crystalline phases, in the temperature regions -195°C and 500°C. The mechanical properties that occurred during the change from the noncrystalline phase through the crystallization process were investigated up to 500°C. These results are discussed in part in terms of the behavior of glasses.