Polynary Telluride Glasses Containing Silver

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POLYNARY TELLURIDE GLASSES CONTAINING SILVER*

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Ternary Si–As–Te glasses are distinguished by the highest glass transition and softening temperatures among glasses transparent to the far infrared[1]). It would appear that glasses containing selenium in the place of at least some tellurium should have still higher softening ranges, but silicon selenide glasses tend to decompose in the melting process as well as at ambient temperatures in moist air[1,2]). In an extensive search[3,4]) with the objective to overcome this limitation by depolymerizing ternary chalcogenide melts and heating them to form viscous structures in similation of the behavior of vitreous sulfur, polynary telluride glasses of unusual composition and properties were obtained. These glasses contained between 1 and 10% silver in an apparently stable arrangement Ag–Se–Si–Te.

The base glass $Si_{35}As_{25}Te_{40}$ was in the compositional range of optimum (maximum) glass temperature and softening point. Mixtures containing 2%Ag and increasing amounts of selenium ($Si_{35}As_{23}Te_{40-x}Ag_2Se_x$) were reacted in sealed vials at 900 °C for 22 hr. The 5% Se glass remained stable for two weeks, but decomposition started soon in glasses containing 10–15% selenium. Mixtures containing 5% Ag ($Si_{35}As_{20}Te_{40-x}Ag_5Se_x$) were reacted at 975–1000 °C for about 20 hr. All glasses containing up to 15% selenium showed no signs of deterioration after six weeks. Mixtures containing 8% Ag were reacted at 925 °C for 23 hr, then at 975 °C for 2½ hr. In some cases signs of surface crystallization were observed. After removal of the surface crystallization glasses containing up to 15% Se were stable in air. Using a reaction temperature as high as 1025 °C for 40 hr crystallization was avoided and glasses containing 15 and 20% Se were stable. Glasses ($Si_{35}As_{15}Te_{40-x}Se_xAg_{10}$)

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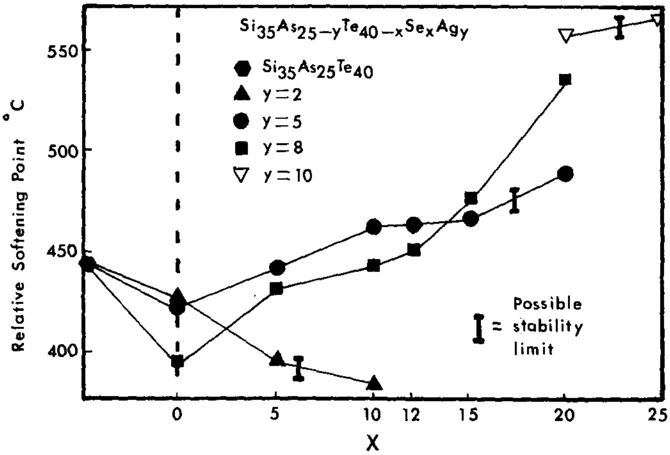

Fig. 1. Softening point variation with Ag and Se.

were reacted at 1025 °C for 40 hr. The glass containing 20% Se was again stable, while that containing 25% Se began to deteriorate.

The incorporation of some selenium in the glasses raises the softening temperature as had been expected. The 10% Ag 20% Se glass ($Si_{35}As_{17}Te_{20}Ag_{10}Se_{20}$) has the remarkably high softening point (560 °C)*. Heat treatment, in some cases, increased the softening point by 25 °C without signs of crystallization (X-ray diffraction tests). These treatments led to temporary surface instability.

Polynary glasses based on this experience are being studied. Silver had been chosen as a model for monovalent elements because of ease of experimentation, but Cs, Rb, K, Na, Tl were first considered for this purpose. Tl and Ag, however, are distinguished by large glass formation regions in sulfur and selenium systems.

Data are summarized in fig. 1.

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* This refers to the softening point as defined by Hilton and Brau [5]).