# Structure and properties of silver phosphate glasses with tungsten trioxide

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Phosphate glasses of the ternary system $Ag_2O$-$WO_3$-$P_2O_5$ were prepared and studied. Altogether 22 glass compositions were prepared and studied in five compositional series: (A) $40Ag_2O$-$xWO_3$-$(60-x)P_2O_5$, (B):$(60-y)Ag_2O$-$yWO_3$-$40P_2O_5$, (C) $zAg_2O$-$20WO_3$-$(60-z)P_2O_5$, (D): $50Ag_2O$-$kWO_3$-$(50-k)P_2O_5$ and (E) $30Ag_2O$-$nWO_3$-$(70-n)P_2O_5$. Basic physical parameters of glasses (density, molar volume, glass transition temperature, dilatometric softening temperature and the coefficient of thermal expansion) were determined. Glass transition temperature increases in the series A, D, E with increasing $WO_3$ content, nevertheless the highest value of $T_g$ = 500°C was reached for the glass of the composition $10Ag_2O$-$50WO_3$-$40P_2O_5$ in the series B. Glass structure was studied by Raman spectroscopy and $^{31}$P MAS NMR spectroscopy. In the studied ternary system glass forming region was determined and glasses with only 10 mol% $P_2O_5$ were successfully prepared. The highest content of $Ag_2O$ in these ternary glasses was 60 mol%. $^{31}$P MAS NMR spectra revealed in the series (B): $(60-y)Ag_2O$-$yWO_3$-$40P_2O_5$ that with decreasing content of $Ag^+$ ions the number of nonbridging oxygen atoms decreases, while the number of W-O-P bridges in the structure increases.

Both Raman and NMR spectra revealed that with increasing $WO_3$ content in the studied glasses the depolymerization of the phosphate network takes place and the glass network is changed to tungstate-phosphate network, in which isolated $PO_4$ units are incorporated into the disordered tungstate network by W-O-P bonds. Tungsten atoms form $WO_6$ octahedra only and with increasing $WO_3$ content isolated $WO_6$ octahedra form chains or even clusters of tungstate units by W-O-W bridges.