Preparation and characterization of gold nanoparticles in silicate glass matrices using aerodynamic levitation coupled to laser heating

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In our contribution, aerodynamic levitation coupled to laser heating (ADL) technique was applied to synthetise silicate glasses samples containing gold nanoparticles. ADL is a device developed for studying thermophysical properties, molten oxide structure, microgravity, and new chemical phases. ADL melting has many advantages compared to traditional melt-quenching. The most significant in our opinion is that it is containerless (i.e., it minimizes heterogeneous nucleation) and it can attain extreme melting temperatures up to 3000 °C, beyond the melting point of most oxide materials. However, these advantages are balanced with some disadvantages, such as the easy loss of volatile components during melting or a relatively small sample size. This unusual technique offering new possibilities for nucleation of gold nanoparticles was compared with conventional melting.

The goal was to add low concentrations of gold into studied glasses and investigate the influence of chemical composition as well as additional heat treatment and used technology on size, shape, and distribution of Au nanoparticles in the glass matrix. First, series of yttrium aluminosilicate glasses (YAS) was prepared. System Y_2O_3-Al_2O_3-SiO_2 was chosen because glasses in this system have advantageous mechanical and optical properties such as high hardness and refractive indices. The properties, composition and structure of the glass were studied by DSC, XRF, XRD. The presence and properties of gold nanoparticles were determined by optical absorption, scanning and transmission electron microscopy. Our experiments with YAS glasses showed that the key factor for melting glasses with gold is the temperature used during the ADL melting process. That was why we shifted our focus to lithium disilicate glass ($Li_2O{\cdot}2SiO_2$) which was chosen because of its low melting temperature. Finally, a series of lithium yttrium aluminosilicate glasses (LYAS) with varying composition and gold content was prepared with the intention to combine the advantageous properties of the two previous systems. The relationship between the optical absorption as well colour of the glass and the shape and distribution of the nanoparticles was studied and discussed.

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