Preparation of glasses with gold nanoparticles using melt-quenching and aerodynamic levitation coupled to laser heating

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Abstract

Aerodynamic levitation coupled to laser heating (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. In our contribution, ADL technique was applied to synthetise glass samples and was compared to conventional melting-quenching technique. The goal of this project was to add low concentrations of gold into studied glasses and investigate the influence of chemical composition, additional heat treatment and used technology on size, shape, and distribution of Au nanoparticles in the glass matrix. First, series of yttrium aluminium silicate glasses (YAS) was prepared. System Y2O3-Al2O3-SiO2 was chosen because glasses in this system have advantageous mechanical and optical properties such as high hardness and refractive indices. 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 (Li2O·2SiO2) which was chosen because of its low melting temperature. Optical quality, absorption and colour of prepared glasses were systematically studied.

Keywords: silicate glass, aerodynamic levitation, gold nanoparticles, crystallization, yttrium aluminosilicate, lithium silicate

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