The role of glass composition on the AuNPs formation in K_2O-PbO-SiO_2 glasses

Vasily Krasnobrov, Maxim Andreev, Yury Belousov, Sergey Karalash, Alexey Zhurbitskiy and Andrey Drozdov, Lomonosov Moscow State University, Centre of Pedagogical Skills, Moscow, Russia

Abstract (300 word limit)

Statement of the problem: In this work we investigated the AuNPs formation in lead flint glasses K2O-PbO-SiO2 in the range 10 – 40% mass PbO (K2O 10%, SiO2 50 – 80%). Although this triple system is well known and commercially available, its structural model has not been developed yet. The binary PbO-SiO2 system is now considered as a system of two glass formers, where a SiO4 network is continuously substituted by PbOx network. Potassium oxide is a modifier that breaks the silica network at lower concentrations of PbO than in binary system. In this research we aimed to observe if the formation of AuNP depends on the lead oxide content in glass. It has been shown that color of glasses with different lead content (10 – 40% PbO) change from red to reddish-brown. The formation of AuNP in glass containing 40% PbO occurs spontaneously without additional heat treatment (self-striking). We explain it with structural changes in glass matrix. In high lead glasses the plasmon peak is downshifted upon prolonged striking or temperature increase, while in glasses with PbO content up to 30% (mass) the same treatment results in bathochromic shift of AuNP plasmon. Therefore, when the glass with 40% PbO is heated at 600°C for 1 hour, plasmon band is at 538 nm. After striking at 750°C for 2 hours plasmon band shifts to 514 nm.

The structural changes in high PbO glass may be explained by large radius of lead. To verify it we introduced erbium. Luminescence spectra did not reveal significant interactions between AuNPs and erbium. We can conclude that in K2O-PbO-SiO2 system with high lead content the Ostwald ripening is violated. As no AuNPs interaction with Er or PbOx networks observed, we assume that high concentration of lead increases viscosity of the glass and therefore AuNPs tend to dissolve.

Image

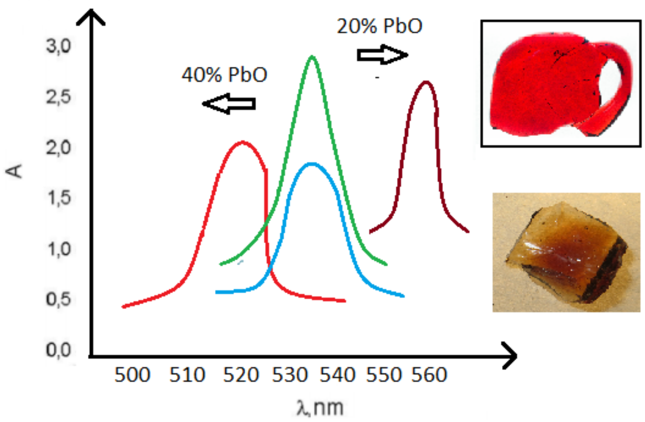

Figure 1. Absorption spectra and glass samples

Recent Publications (minimum 5)

1. F. E. Wagner, S. Haslbeck, L. Stievano, S. Calogero, Q. A. Pankhurst & K. -P. Martinek (2000) Before striking gold in gold-ruby glass. Nature 407: 691–692
2. T. Jitwatcharakomol, E. Meechooowa, M. Jiarawattananon, S. Jiemsirilers (2012) Kinetic investigation on the Color Striking of Gold Ruby Glass. Procedia Engineering 32:584-589.
3. A. Drozdov, M. Andreev (2018) The role of microstructure in dichroic properties of the Lycurgus cup glass. 42nd International Conference & Exposition on Advanced Ceramics and Composites. Abstract Book:105.
4. C. Stalhandske, T. Bring & B. Jonson (2006) Gold ruby glasses: influence of ironand selenium on their colour. Glass Technol.: Eur. J. Glass Sci. Technol. A 47 (4):112-120
5. M. Eichelbaum, K. Rademann, W. Weigel, B. Lochel, M. Radtke, R. Muller (2007) Gold Ruby Glass in a New Light: On the Microstructuring of Optical Glasses with Synchrotron Radiation. Gold Bulletin 40(4):278-282.

Biography (150 word limit)

Andrey Drozdov,
Ph D, Associate Prof.
The field of his scientific interests includes the coordination chemistry of lanthanides. From 2016 he focused his attention on such aspects of glass chemistry as historical glasses such as Licurgus cup and gold ruby, as well as the problem of color generation in glasses by ionic colorants and nanoparticles.

Email: camertus@mail.ru

Notes/Comments: