



Effect of alkali metal ions on the structure and growth of copper nanoparticles on the surface of borophosphate glasses

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Glasses are materials widely used in everyday products. Even so, the development of new functional glass-based materials continues to grow, mainly due to the ability to tailor their composition for specific applications. One example is the growth of transition metal nanoparticles, such as Ag, Cu, and Ni, on the surface of phosphate-based glasses, which have been applied in organic reaction catalysis and SERS sensing. The growth of copper nanoparticles (CuNPs) on the surface of borophosphate glasses occurs when these materials are thermally treated in a hydrogen atmosphere, where copper ions migrate, reduce, and nucleate to form nanoparticles. It has been shown that the glass composition influences the growth conditions of CuNPs: The growth temperature of these nanostructures is about 100 °C lower in glasses containing potassium compared to the same composition with sodium, which is likely related to the ionic radius of these cations and their impact on the glass network structure. In this context, this study analyzes the effect of different alkali metals —Li, Na, K, Rb, and Cs— on the growth of CuNPs. Other characterization techniques, such as density, UV-Vis and Raman spectroscopies, Thermal Analysis, and Nuclear Magnetic Resonance, were used to evaluate how the chemical properties of these cations, such as ionic radius, ionic field strength, and molar mass, impact the glass network structure. Similarly, the growth behavior of CuNPs is evaluated for different compositions using temperature-programmed reduction. Finally, the generated CuNPs are analyzed by X-ray Diffraction and Scanning Electron Microscopy. In this way, by understanding how glass composition influences nanoparticle formation, new materials can be proposed and optimized for applications in heterogeneous catalysis and SERS sensing.

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References

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