Structure of sustainable lead-free low-melting vanadate glass

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Vanadium based glasses (vanadate glasses) with a sealing temperature of around 400 °C are now being applied in electronics devices, such as in crystal oscillators and Micro Electro Mechanical Systems (MEMS) as an alternative sealant to the toxic low-melting point glasses containing lead and fluorine. We have developed an Ag_2O-V_2O_5-TeO_2 glass with a sealing temperature of 200-300 °C. However, the structure of the Ag_2O-V_2O_5-TeO_2 glass is still unknown and hence it is necessary to reveal the relationship between the atomistic structure and the property of the vanadate glass.

In this study, we performed high-energy X-ray and neutron diffraction, extended X-ray absorption fine structure (EXAFS), and anomalous X-ray scattering (AXS) [1] measurements on an Ag_2O-V_2O_5-TeO_2 glass to obtain sufficient element specific structural information on constituent atoms. To uncover the glass structure in detail, we constructed a three-dimensional atomistic structure model for Ag_2O-V_2O_5-TeO_2 glass by employing the reverse Monte Carlo [2] technique based on X-ray/neutron diffraction, EXAFS and AXS data. Furthermore, topological analyses were applied to the three-dimensional glass structure model to extract topologies related to the low-melting property.

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