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Particle size-dependent sintering-crystallization mechanisms in oxide glasses with surface crystallization

Viscous flow sintering is a key route in ceramic processing that promotes particle coalescence driven by surface energy minimization. This process is widely used in industry; it lowers manufacturing temperatures in ceramic processing and increasingly enables advanced photonic technologies. Achieving the desired material properties requires precise control of densification. In non-crystallizing glasses, microstructural evolution proceeds through neck formation, collapse of interconnected pores, and shrinkage of spherical pores within a continuous matrix. However, most glasses crystallize above the glass transition, which hinders viscous flow and makes densification and microstructural evolution more complex and less predictable. We analyzed the microstructural evolution of diopside glass powder compacts during sintering with concurrent crystallization, considering different particle sizes, using optical microscopy and 3D synchrotron X-ray tomography. There is a critical particle size for forming a continuous crystallized layer on the particle surface. The sinter-crystallization mechanism is governed by the number of surface nucleation sites per particle. Phase evolution (glass, crystals, and intra- and inter-particle pores) was quantitatively assessed via 3D phase segmentation. Applying this method for glasses with stoichiometric crystallization is challenging, as phase X-ray attenuation differs only in atomic structure. The implications of this limitation will be discussed.

Professional Status of the Speaker

Senior Scientist

Interest in submitting a paper in a special issue of

No interest

Invitation letter for visa

No

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