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In situ investigation of the promotion of sintering by introducing the second phase powders

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Summary

In this work, the influence of the second phase fine powders on solid state sintering process was in situ investigated by synchrotron radiation X-ray computed tomography (SR-CT) technique. Microstructure evolution of the pure SiO2 powders and SiO2 powders mixed with Si3N4 fine powders during sintering is observed respectively from the SR-CT reconstructed images.

Sintering process, as the final and the most crucial step for the preparation of various ceramic materials, will inevitably affect the microstructure and properties of the material. The inclusions with different kinds or particle size may promote or hinder the sintering process. Mixed powder system is widely applied to prepare some particular material. Therefore, many scholars pay attention to the research on the influence of inclusions on the original components during solid state sintering.

In order to avoid interrupting the sintering process and the destruction of the specimen, the SR-CT technique is selected in this paper. The pure SiO2 powders and SiO2 powders mixed with Si3N4 fine powders are used for comparative sintering experiment. The temperature was controlled at a relatively low degree to avoid various kinds of complex chemical reactions.

The 3D reconstructed images provide a good understanding of various kinds of sintering phenomena. The influence of the Si3N4 fine powders on the sintering process of the original system was quantitatively analyzed:

- The densification rate of the sample became bigger, and the sample got a larger relative density after sintering.

- The evolution of the pore shape was promoted. More pores got a higher degree of sphericity.

- The sintering neck size at different sintering time was calculated. The sintering neck between the SiO2 particles grew faster. The neck growth exponent became 4.45 from the original 7.89.

All the parameter variation indicates that the sintering process was promoted by adding the Si3N4 fine powders. The particle size of the Si3N4 fine powders is considered as the main reason to explain why the experimental result is different from that of several other researchers'. The qualitative analysis of the way how the second phase powders accelerate the sintering process was carried out.