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Contrasting Energy Efficiency in Various Ceramic Sintering Processes

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Abstract

Regarding the recent energy costs and environmental concerns, energy efficient and sustainable manufacturing processes have become important topics. In this paper, a number of novel sintering methods were reviewed to illustrate their potential to reduce energy consumption during ceramic processing. Three approaches: adding sintering aid, increasing heating rate, and applying electric field on the reduction of the energy consumption were considered, and the underlying mechanism in each approach was explored. Next, the laser sintering that is utilized in additive manufacturing approaches and the new Cold Sintering Process (CSP) were introduced as potential techniques for the further improvement of energy efficiency. Since the need of furnaces was eliminated in these latter techniques, their heat dissipation during sintering would significantly decline. For example, it was demonstrated that the energy consumption for $BaTiO_3$ powder can decrease from 2800 kJ/g for conventional techniques to 30 kJ/g for CSP. A simple parameter, "Normalized Excess Energy", was used as a first order approximation to compare the energy merit in the different sintering techniques.

Keywords: Energy efficiency; Ceramics; Sintering;