EVALUATING THE MICROWAVE SINTERING BEHAVIORS OF BINDER-JETTED ADDITIVELY MANUFACTURED ALUMINA

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Microwave sintering has the potential to densify and provide structural stability to ceramic oxide parts through the reduction of energy barriers. However, the main challenge with microwaves is understanding the effects of processing parameters on the sintering process, supplemented with sintered ceramic characterization, mechanical properties exploration, and thermal history inspection. To reduce thermal distortion and the emergence of thermal history before sintering, binder jetting, a less energy-intensive additive manufacturing process, is gaining popularity in the green parts fabrication from ceramic powders at room temperature. This experimental work evaluates the behavior of microwave sintered ball-milled alumina by comparing its performance with conventional sintering studies. Samples were fabricated using conventional pressing and binder jetting to investigate the effect of green part starting density. Heating profiles of 2.45 GHz frequency microwaves were parameterized to study the effect of sintering temperature and holding time with a high heating rate on the powder's densification behavior, microhardness, microstructure, and phase composition. Green samples with a higher starting density and reduced porosity ensured a higher final density with traces of microcracks in the microwave sintering than in the parallel conventional sintering process. The density and hardness of both microwave sintered and conventionally sintered binder-jetted and powder-pressed samples improved with increasing the sintering temperature and holding time, but a comparatively higher heating rate in the microwave field assisted in rapid (< 1 hour) densification due to enhanced microwave field coupling and susceptibility. Pore closure, particle agglomeration, and softening of the particle edges resulted in a more favorable grain structure that increased the microstructure uniformity of the microwave sintered alumina samples. In microwave-assisted field enhanced processing, coalescing these results with knowledge about ceramic powder preparation and processing parameters will increase the feasibility of its implementation in the advanced industries ranging from healthcare, and electronics to high temperature tooling where metals cannot survive.