Microwave Processing of Ceramics

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Detailed investigations have been undertaken towards harnessing the phenomenon of microwave heating (MWH) for the synthesis and processing of ceramic materials. Its potential has been demonstrated in different variants of ZrO₂, ZTA, Al₂O₃ – SiC composites, HTSC, etc, resulting in rapid densification rate. Similarly for synthesis routes like solution based homogeneous precipitation or solid state reaction in LiO - Ta₂O₅ system, an enhancement in reaction kinetics was achieved. The reduction in processing time thus provided a larger throughput rate. Stabilized zirconia has a large concentration of point defects which makes it an excellent susceptor of microwave energy (above 600°C temperature). Sintering assembly was constructed by modifying 1.5 kW, 2.45 GHz microwave oven. Green samples were placed inside a casket made of alumina and zirconia fiberboards. This was covered with alumina wool (microwave transparent) having low thermal load, for heat containment. To initiate heating, a hybrid mode was adopted using a thin layer of SiC powder as a susceptor. This was found to be essential in minimizing the thermal gradients within the sample. For temperature sensing a shielded R-type thermocouple was used. Samples of 9Y-CSZ and 3Y-TZP were sintered at 1625°C and 1350°C respectively, in microwave furnace. Conventional sintering of the above materials, however, was carried out at 1700°C and 1400°C respectively in resistive heating furnace to achieve comparable density. Microstructural features of 9Y-FSZ show an equiaxed grains (~15 µm) with finely dispersed porosity.
For 3Y-TZP, grains were relatively fine (~100 nm) with a monomodal distribution. The grain boundaries were completely free of amorphous phase indicating that the high purity of the material is retained even after several processing steps.

A combined effect of dielectric heating and the field enhanced mobility during diffusion is manifested in the observed rapid kinetics making the processing cost effective for refractory ceramics systems.

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