

A novel Multi-Phase Flash Sintering (MPFS) technique for 3D complex-shaped ceramics

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Flash Sintering (FS) is a new field assisted sintering technique, first proposed by Raj and co-workers in 2010 [1]. When NTC ceramics are heated under moderate electric fields, an abrupt increase of electrical conductivity takes place at a certain *onset* temperature, resulting in a rapid densification at greatly reduced temperatures. However, a few problems still constrain the technological applications of FS, such as preferential current path issues due to uni- or bi-directional current flow and microstructural heterogeneities caused by redox reactions at the electrodes in ionic conductors [2].

In this work, we propose a multi-phase configuration to enhance FS in ceramic materials. Three or more electrodes are equidistantly placed over the edges of the sample and connected to a multi-phase power supply, creating a rotating electric field across the entire sample. It is shown that 3D complex-shaped specimens of materials with diverse types of electrical conductivities (ZnO, 8-mol% Ytria-Stabilized ZrO₂ and BiFeO₃), can be homogeneously sintered in a matter of seconds at furnace temperatures lower than those used in traditional FS under the same applied voltage. Also, undesired local phenomena are avoided because of the uniform electric field distribution. All in all, MPFS can be considered an interesting methodology for industrial applications due to its smaller energy footprint in comparison to traditional sintering techniques and even to conventional FS.

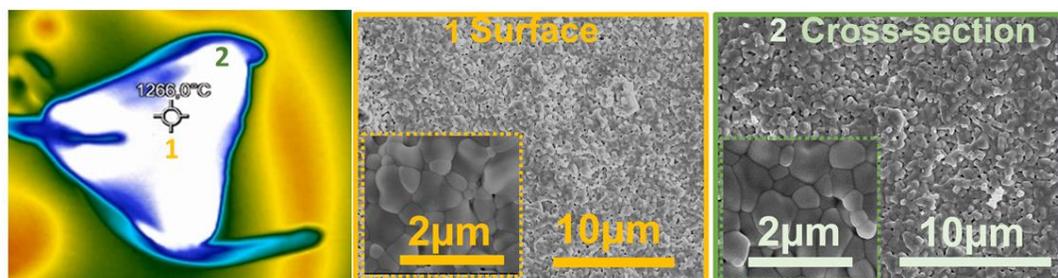


Figure 1. IR thermographic image during MPFS of an 8YSZ 3D triangle and SEM micrographs of the marked areas (center and electrode).

References

[1] M. Cologna, B. Rashkova, R. Raj, *J. Am. Ceram Soc.*, **2010**, 93, 3556-3559

[2] W. Qin, H. Majidi, J. Yun, K. van Benthem, *J. Am. Ceram Soc.*, **2016**, 99, 2253-225