FIELD ASSISTED PROCESSING OF 3D PRINTED CERAMICS

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Advanced ceramic products for highly demanding applications in electronics, energy, healthcare and defence sectors require densification/sintering, a high temperature process (~1000–2000^{o}C) that in industry can take days. The amount of energy needed, and CO_2 emitted, is therefore very significant. Conventional processing of these functional devices/components are often plagued by interfacial issues, unwanted grain growth and limitations of co-firing dissimilar materials. Thus, rapid and efficient sintering methods such as SPS, Microwave Assisted Sintering (MAS) and Flash Sintering (FS) are continuously being developed. These approaches referred as Field Assisted Sintering Techniques (FAST) use an external field that was demonstrated to have a positive effect on densification. For example, the FS method, for reasons that are far from fully understood, has yielded full densification in very short periods (5 s) at very low furnace temperatures (850^{o}C) for zirconia, and at a surprisingly low temperature of 325^{o}C for Co_2MnO_4 spinel ceramics. The associated time and energy advantage is estimated to be staggering, as well as the ability to tailor the microstructure. In this talk, we will have a closer look at MAS and FS methods– one a well-established and the other a newly emerging densification method. The MAS method can be suitable for the processing of various simple and complex shaped engineering components, the early use of FS method was restricted to dog-bone shaped ceramic specimens – that are both difficult to make and do not have much industrial applicability. However, the recent developments have demonstrated that FS can also be used to sinter different sample shapes. We investigated the feasibility of sintering of 3D printed ultra-low loss 5G microwave dielectrics, YSZ/ZTA biomedical components using MS and FS methods along with measurements of shrinkage and thermal mapping. This talk will review these developments on FS along with the operative mechanisms in comparison with MAS.