REACTION FLASH SINTERING OF MULTIPHASE CERAMICS

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A new phenomenon where the application of modest electric fields can lower the sintering temperature well below 1000 ^{o}C, and the time to just a few seconds, is being called flash sintering. For example yttria stabilized zirconia which normally requires several hours at 1400 ^{o}C can be sintered in mere seconds at 800 ^{o}C with fields of about 100 V cm^{-1}. The method has been applied to various classes of ceramics drawing from semiconductors, electronic or ionic conductors, and insulators. Flash sintering is further accompanied by intense electroluminescence and a non-linear increase in electrical conductivity. A mechanism that can explain the simultaneous rise in chemical diffusion and a change in the electronic structure remains elusive, though the generation of vacancies, interstitials, electrons and holes via Frenkel pairs appears to apply. Non-linear lattice vibrations also appear to be at play.

In-situ experiments carried out at APS and NSLA-II synchrotrons at Argonne and Brookhaven National Laboratories is revealing new effects of flash related to unusual “far from equilibrium” phase transformations. Most recent work, which will be highlighted during this talk, is related to reaction flash sintering, where constituent oxides simultaneously react and sinter in mere seconds to form single phases of complex oxides, usually for functional applications. This unique feature of flash enables the synthesis of dense compounds of ceramics which are usually not accessible by conventional sintering because of low-melting and volatile constituents as well as the presence of intermediate phases. Among the examples is sintering of pure phase bismuth ferrite from bismuth oxide and iron oxide in mere seconds with flash. Other such examples, including the sintering of multiphase composites, will be described.

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