STRUCTURAL AND MICROSTRUCTURAL MODIFICATIONS OF MATERIALS BY MICROWAVE FIELD TREATMENTS

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Solid state reaction carried in a multimode microwave chamber has shown radically different reaction sequence compared to conventional heating the question of its link to radiation field persists. In the present study, a single mode TE_{103} cavity has been used for field exposure studies. The samples are treated inside a quartz reaction tube in which, the position of E-field lies at center whereas the position of H-field lies along the sides of the cavity. The maximum height of the sample does not exceed 7mm. Enormous differences are shown to occur for certain families of common ceramic phases depending only on which of the E or H fields were used. The most significant effects and sharpest differences between reactions at the E and H nodes have been found in the case of ferroic oxides. Phases such as Fe_3O_4 or binary compounds such as $BaFe_{12}O_{19}$ are rendered non-crystalline to XRD in a few seconds in the H field, although they show no bulk evidence for melting. In the case of $BaFe_{12}O_{19}$ synthesis, the microstructures are unique, showing smooth glass-like regions with regular waves parallel to each other. In the E field node the identical pellet components react completely and form large euhedral crystals of a single phase. The phenomenon of de-crystallization or formation of nano-glasses was confirmed for all the 3d ferrite phases.

Similar results were observed when highly doped Si is treated in E-field. Highly doped n-type silicon powder responds aggressively to a 2.45 GHz microwave E-field whereas it remains completely unperturbed in the H-field. In the E-field, after about 30 seconds of treatment, the silicon powder attained sub-melting temperatures and thus coagulating to a bulk solid piece. XRD analysis of the surface and the cross-section of this solid material failed to show any detectable peaks, ascertaining the fact that the material had decrystallized. The Raman spectra of the material had broad and shallow peaks quite different from the thin, sharp lines exhibited by Si wafer. It appears that the E-field treatment has considerably distorted the lattice structure creating lattice strains throughout the sample. These lattice strains were relieved by grinding (recrystallized).