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Electric Field Assisted Sintering and Related Phenomena Far From Equilibrium

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ELECTRIC FIELD EFFECTS ON GRAIN BOUNDARY FORMATION AND GRAIN GROWTH

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The application of electric fields can enable the accelerated consolidation of materials during field assisted sintering, such as spark plasma sintering or flash sintering. Although such techniques are already employed for the synthesis of a wide variety of microstructures with unique macroscopic properties, a fundamental understanding of the atomic-scale mechanisms for grain boundary formation and subsequent migration in the presence of electrostatic potentials is mostly absent from the literature. We have designed experiments to specifically de-couple the effects of heating and applied electrostatic fields during consolidation. In situ transmission electron microscopy studies were carried out with new sample holder designs to investigate densification and grain growth mechanisms in the absence and presence of electrical fields [1,2]. Quantitative experimental observations reveal lowering of activation energies for both densification [2] and grain growth [3] as a consequence of the applied electric field strength. In the specific case of flash sintering, microstructural characterization furthermore reveals that electrode effects can lead to non-homogeneous microstructure evolution during processing. Examples for yttrium-stabilized ZrO_2 and $MgAl_2O_4$ spinel will be discussed.

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