Electric Field Assisted Sintering and Related Phenomena Far From Equilibrium

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FEATURES OF GRAIN GROWTH AND GRAIN BOUNDARY FORMATION UNDER MICROWAVE AND SPARK PLASMA SINTERING CONDITIONS

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Key Words: SPS, microwave sintering, nanostructure, microstructure.

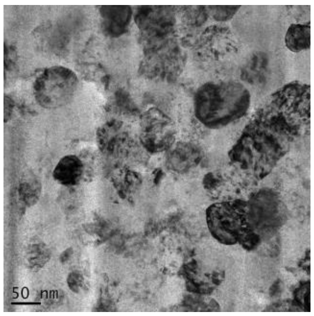

Figure 1 – HRTEM micrograph of nano-TiN powder after SPS consolidation

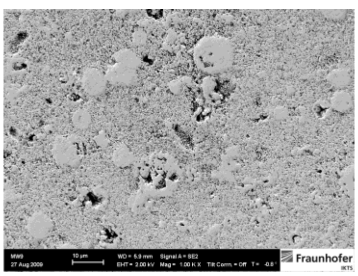

Figure 2 – FESEM micrograph of nano-TiN powder after MWS consolidation

The feedback properties of particulate nanomaterials versus their structure parameters (grain size, pore size), were found much more sensitive than that in conventional materials [1-3]. Among them field assisted sintering techniques including SPS and microwave sintering (MWS) were intensively developed [4-9]. The effect of inhibited grains growth for nanomaterials was established for Field Assisted Sintering Technology [4,5,8,9].

The FAST or Spark Plasma Sintering (SPS) is a rapid rate consolidation technology where effect of electromagnetic field enhanced by external pressure. The studies of FAST densification for nano-TiN shows the possibility to substantially inhibit the grain growth and fabricate materials with grains size in nanometric scale (fig.1) [4]. However, the “size effect” for the consolidated materials applying standard SPS schedules for nanopowders consolidation still not achieved. In this case the grain boundaries and other mesoscale interfaces, which play an important role in nanomaterials properties, were formed weakly or contaminated [4,5].

During microwave sintering of nanopowders (materials with high specific surface which actively absorb microwave power) expected appearance of surface related effects, which affected on mass transport mechanism and grains boundary diffusion [7-9]. Moreover, powders with fine particles (below 100 nm) with increased surface, which interact more effectively with microwaves, demonstrates decreasing of materials melting temperature. Intensive densification for nanostructured materials could be attributed to appearance of surface melting of nanoparticles or some non-thermal effects (fig.2). This is the reason to investigate microwave processing of nanomaterials more scrutinize as well as apply the MWS and SPS methods for production of nanocomposites with grains size below 50 nm and enhanced properties.

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