Mechanochemical synthesis and characterization investigations of rare-earth borides and tungsten boride and tungsten silicide powders fabricated from low cost oxide powders

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Room temperature mechanochemical routes were carried out in the syntheses of nano-sized rare-earth boride (MB_6 , M = La, Sm, Ce) powders from M_2O_3–B_2O_3–Mg blends, tungsten boride powders from WO_3 - B_2O_3 - Mg blends and tungsten silicides from WO_3 - SiO_2– Mg powder blends. All synthesis reactions were drivenby high-energy ball milling and were gradually examinedin terms of milling duration and process control agent. Following the mechanochemical synthesis, unwantedMgO phase and Fe contamination worn off from themilling vial/balls were removed with HCl acid leachingunder the effect of ultrasonics stirring. Pure rare-earth boride, tungsten boride and tungsten silicide powders were obtained after repeated centrifuging, repeated washing and drying. Subsequent annealing wasperformed in a tube furnace under Ar atmosphere inorder to reveal residual elements. Phase andmicrostructural characterizations of the milled, leachedand annealed powders were performed using X-ray diffractometry (XRD), differential scanning calorimetry(DSC), scanning electronmicroscopy (SEM) andtransmission electron microscopy (TEM) techniques. High-purity (> 99.99 %) LaB_6, CeB_6 and SmB_6 powders were successfuly synthesized having average particle sizes of 80 nm, 86 nm and 81 nm, respectively.

Using stoichiometrically excess amounts of B_2O_3, pure W_2B_5powders with an average particle size of 226 nm and an average grain size of 55.3 nm were successfully synthesized. Likewise, TEM analysis revealed that pure W silicide nanoparticles with an average size of 97 nm were encapsulated by SiO_2 layers with an average thickness of 15 nm.