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Mechanical, Structural and Thermodynamic Features of High Energy Milled Cr3C2-25(Ni20Cr) Composite Powders

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This paper presents mechanical, microstructural and thermodynamic features of Cr3C2-25(Ni20Cr) powders that were high energy milled for different times. Severe plastic deformation is introduced in the powders and a small part of the energy spent in the process is stored in the crystal lattice. Crystallite size, microstrain and lattice parameter of the powders were determined using x-ray diffraction measurements (Rietveld method). The evolution of microstrain with crystallite size revealed a critical crystallite size (DCRIT = 28 nm; tMill = 16 h), where the microstrain reached a maximum [?MAX (%) = 1.17], and then decreased. The lattice parameter showed an opposite behavior (aMIN = 3.5417A). This suggested occurrence of “size effects” and aspects related to strain gradient plasticity are discussed. Stored energy in the crystal lattice was determined from enthalpy variation of the powders, and the graph of ?H vs 1/D also showed a maximum (?HMAX = 722 mcal) for powders milled for 16 h. Microstructural features like small angle grain boundaries and microtwins where studied by TEM. The influence of grain boundaries on microstrain was studied. Modifications in microstructure are discussed based on dislocation density, which is related to crystallite size and microstrain in the crystal lattice. A model for dislocation density evolution has been suggested. The dislocation density at the critical crystallite size was around 1.7 x 1011 cm-2. The dimensions of the slip bands in the material were estimated (xMAX = 3.1 ?m).