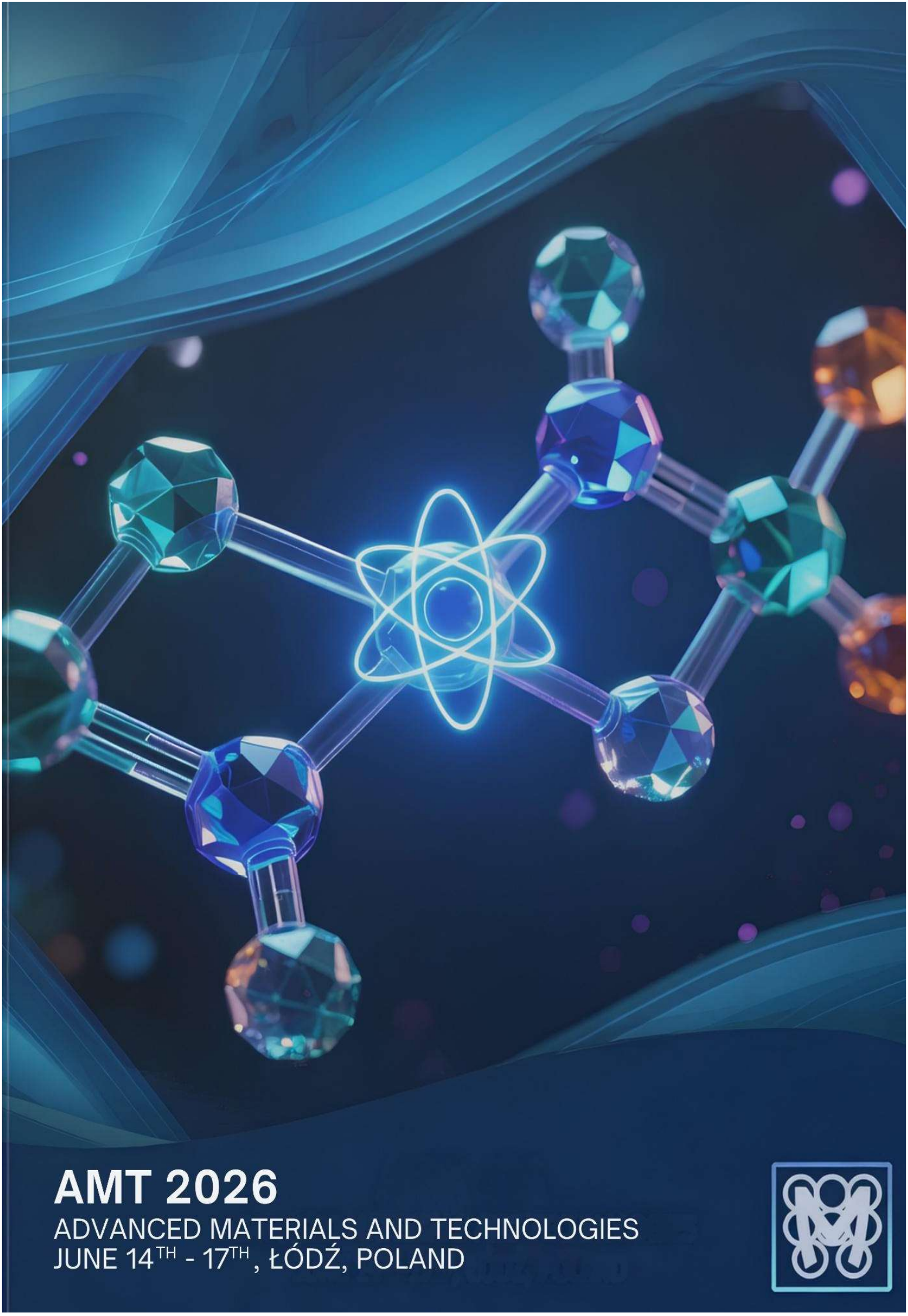

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Microstructure and High-Temperature Compressive Behavior of a Nb-Ti-Al-Cr Refractory Complex Concentrated Alloy Fabricated Via Mechanical Alloying and Sintering

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Abstract

This work investigates the development and characterization of high-temperature refractory complex concentrated alloys (RCCAs) within the Nb-Ti-Al-Cr system, fabricated via powder metallurgy. The fabrication route involved the mechanical alloying (MA) of elemental powders, followed by conventional sintering. This study aims to elucidate the effects of chemical composition and milling parameters on the microstructure, phase evolution, and mechanical properties of the synthesized alloys. High-purity Nb, Al, and Cr powders blended in two distinct atomic ratios were utilized as starting materials. Powder morphology, phase evolution, and chemical composition were evaluated using scanning electron microscopy (SEM), X-ray diffraction (XRD), and energy-dispersive X-ray spectroscopy (EDS), respectively. High-energy ball milling was performed for up to 120 cycles, and the consolidated green compacts were subsequently sintered at 1400°C. The microstructural features, microhardness, and compressive behavior of the sintered samples were investigated both at room temperature and at elevated temperatures (500°C and 800°C).

The results demonstrate that increasing the number of milling cycles promotes microstructural homogenization and eliminates the initial layered structures. Concurrently, Laves phases and Nb-/Ti-based solid solutions were formed during the milling process. The microstructure of the sintered alloys exhibited a multi-phase morphology with a heterogeneous elemental distribution. The microhardness of the consolidated alloys showed a significant increase compared to the raw constituent materials. Compression testing revealed typical brittle behavior at room temperature; however, at elevated temperatures, a reduction in yield strength was accompanied by a substantial increase in plastic deformation.

Keywords: complex concentrated alloys, mechanical alloying, powder metallurgy, microstructure, mechanical properties

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