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Microstructural Features and Mechanical and Tribological Properties of Fe–Cu–Ni–Sn Composites Precipitation-Hardened with CrB2 Additions

Abstract: The structural features, hardness, elastic modulus, and wear resistance of Fe–Cu–Ni–Sn composites with different CrB2 contents, produced by cold pressing and subsequent sintering with additional hot pressing, were studied by X-ray diffraction, scanning electron microscopy, microindentation, and tribological testing. The micromechanical and tribological tests were performed on composite samples 10 mm in diameter and 5 mm thick in dry friction conditions. The test results showed that the mechanical and tribological properties of the composites depended on the CrB2 content. The microhardness and elastic modulus of the samples varied from 1.2 to 9.2 GPa and from 110 to 245 GPa, respectively, depending on their composition, resulting from the uneven distribution of α-Fe, Cu, Cu9NiSn3, NiSn3, and CrB2 phases. The addition of 2 wt.% CrB2 to the 51Fe–32Cu–9Ni– 8Sn composite increased its hardness from 1.2–2.8 GPa to 2.0–4.5 GPa and the elastic modulus from 110–190 GPa to 130–200 GPa and decreased the wear rate from 22.93 · 10–3 to 10.19 × 10–3 mm3 · N–1 · m–1. The mechanism of increasing the wear resistance of the composite sample containing 2 wt.% CrB2 in comparison with the starting composite was associated with the refinement of iron and copper grains from 5–40 μm to 2–10 μm and the presence of discrete areas of greater hardness and higher elastic modulus. A further increase in the CrB2 content from 2 to 8 wt.% in the composite was accompanied by a simultaneous increase in hardness from 2.0–4.5 GPa to 4.8–9.2 GPa, elastic modulus from 130–200 GPa to 150–245 GPa, and wear

rate from 10.19 ×10–3 to 16.68 ·10–3 mm3 · N–1 · m–1. The higher wear rate of these composites was due to excessive brittleness caused by excessive CrB2 content.

Keywords: composite, concentration, structure, particle size, hardness, elastic modulus, friction coefficient, wear resistance

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