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Microstructure, mechanical and tribological properties of nickel-aluminium bronze

alloys developed via gas-atomization and spark plasma sintering

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Abstract: This work investigated the effect of sintering temperatures (600-750 °C) on mechanical and

tribological behaviors of nickel-aluminium bronze (NAB) alloys developed by gas atomization and spark

plasma sintering. Results indicated an increase of the volume fraction of B2-type NiAl precipitates with

increasing sintering temperature, leading to an improvement of the yield strength and the wear resistance.

Specifically, detailed microstructural analyses of sintered NAB alloys at 750 °C showed the presence of

ultrafine grains with an average size of 367 nm, nanoscale twins with a volume fraction of 11.7% and

dislocations with a density of  $1.3 \pm 0.1 \times 10^{14}$  m<sup>-2</sup>. A much higher yield strength of 620 MPa was obtained in

NAB, if compared to that of conventional cast counterparts (280-440 MPa). Estimations of strengthening

mechanisms suggested the predominant mechanism of grain boundary strengthening (335MPa) for NAB

alloys with contributions from precipitate strengthening (54 MPa), dislocation strengthening (75 MPa), twin

boundary strengthening (89 MPa) and solid solution strengthening (50 MPa). Moreover, dislocations was

blocked at twin boundaries to form complex dislocation barriers and networks, further contributing to the high

strength. The high wear resistance of NAB could be ascribed to the reduction of the local stress around crack

tips due to the high elastic modulus mismatch  $(E_{NiAl}/E_{Cu})$ , and to the crack extension toughening near the

interface of the matrix and the precipitate caused by the high plastic mismatch  $(\sigma_{NiA}/\sigma_{Cu})$ .

**Keywords:** Characterization; Copper alloys; Powder methods; Grains and interfaces

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