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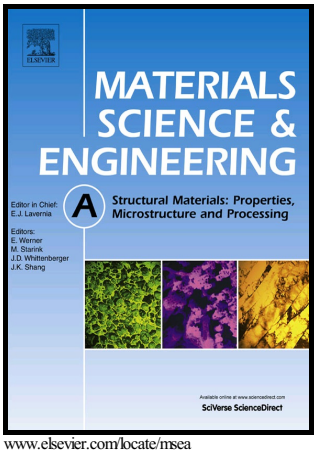

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Abstract

We present a novel alloy design strategy for cost-efficient high modulus steels with an increased stiffness / mass density ratio. The concept is based on the liquid metallurgy synthesis of Fe – Cr – B based alloys, straightforward processability, and well tuneable mechanical properties via plain heat treatments. The base alloy Fe – 18 Cr – 1.6 B (wt.%) contained 14 – 17 vol.% of $(Cr,Fe)_2B$ particles of ellipsoidal morphology in a ferritic matrix. Hot rolled materials revealed a specific modulus of 32.8 GPa g^{-1} cm^3, exceeding that of conventional Fe-Cr steels by almost 30 %. Mechanical properties obtained are comparable to TiB_2 based high modulus steels. Addition of 1 wt.% Cu to the base alloy did not interact with the formation, fraction, size and morphology of $(Cr,Fe)_2B$ particles, and allowed to mildly increase the strength values by ageing treatments, however at the price of a reduction of the specific modulus. C additions of 0.2 wt.% did not affect the $(Cr,Fe)_2B$ particle microstructure greatly, but free C dissolved in the matrix enables for the first time to utilize the wide range of microstructures and mechanical properties of established C-containing high strength steels also in high modulus steels.

Keywords: stiffness, density, strength, composite, corrosion resistance

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