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Alloy design of ultra-high strength steels hardened by nanoscale particles for structural applications

Recent studies have demonstrated that Fe-based alloys are perfect metallic materials for strengthening by a combination of nanoscale particles including nanoscale atomic clusters, intermetallics and carbides. This paper will summarize our recent study of computational aided design of ultra-high strength steels hardened by of uniform distributions of nanoscale particles in 2-10 nm. The precipitation processes are carefully controlled through the nucleation and growth in the alloys with controlled alloy compositions and heat treatments. Computational material calculations together with applications of the state-of-the-art micro-analytic tools are critical for the design of these multiple-component Fe-based alloys. The composition and morphology of these nanoscale particles have been characterized by detailed analyses of structural features obtained from atom probe tomography (ATP). The precipitation mechanism and sequence are found to be sensitive to some key elements in these alloys. Our results have demonstrated that the strength of nanostructured steels can reach to as high as 2000 MPa with a good tensile ductility and dimple-type fracture behavior. This series of nanostructured alloys have many important applications in transportation industries and energy conversion systems.

Biography

C T Liu recieved his PhD from Brown University, USA in Materials Science and Engineering. He currently serves as Distinguished Professor in College of Science and Engineering at the City University of Hong Kong. His research areas include physical metallurgy and mechanical behaviour of metals, alloys, nanostructure materials, intermetallic compounds and bulk amorphous alloys, microstructure and phase transformation, alloy design of high-temperature structural materials, precious metal alloys, Ti-base alloys, metal-matrix composites and innovative material processing. He authored/co-authored over 135 journal publications and 26 books and many other reports and publications.

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