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Nanostructure engineering for improvement of fatigue properties of metallic materials

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With respect to the perspective engineering applications of Nanostructured (NS) metallic materials, their cyclic deformation response is another essentially crucial concern owning to safety issues. Compared with their coarse grained references, NS materials generally exhibit enhanced High-cycle Fatigue (HCF) and decreased Low-cycle Fatigue (LCF) properties. Our recent investigations revealed that prominent improvement of the LCF lives and HCF strengths, especially fatigue endurance limits of NS metals and alloys, can be simultaneously achieved with decreasing their Stacking Fault Energy (SFE). These upgraded fatigue performances with lowering the SFE in NS materials can be attributed not only to the simultaneous increase of their monotonic strength and ductility in macroscale, but also to the crucially decreased cyclic softening behavior in terms of grain coarsening and shear banding in microscale. In addition, the dominant fatigue damage micro-mechanism was also transformed inherently from extensive Grain Boundary (GB) migration to other local GB activities such as atom shuffling or GB sliding/rotation with the reduction of the SFE. Owing to the limitation of their intrinsic fatigue mechanisms, the fatigue endurance limits of NS alloys cannot always acquire appreciable improvement with their monotonic strengths. However, tuning the microstructures to harvest a recrystallized nanostructure can significantly enhance the fatigue strength of NS materials despite the lower tensile strength. These results is important both scientifically for the in-depth comprehension of their deformation behavior and technologically, for assessing their service utilities in safety-critical structural components and also open up promising venues for materials design to possess optimal mechanical properties.

Biography

Xianghai An has completed his PhD in Shenyang National Laboratory for Materials Sciences, Institute of Metal Research, CAS in 2012. He is also conferred the Alexander von Humboldt Fellowship in 2016 (relinquished) and Dean's Research Award for 2018. Up to date, nearly 60 papers have been published in top journals with citations of >1550 and H-index of 23, exceptional in comparison with his peers in the field.

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