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P3.198 Quantitative analyses of interfacial strain by diffraction contrast TEM imaging in ODS steel

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Oxide dispersion strengthened (ODS) steel is one of the most promising candidate structural materials for fusion nuclear systems. It is widely recognized that to design and to control macroscopic materials properties of ODS steel successfully, a fundamental understanding of the atomic-scale structure and chemistry of oxide/matrix interfaces is necessary, owing to the fact that oxide/matrix interfaces plays a key role in determining the macroscopic properties. Lack of a statistical quantitative measurement method has been a major obstacle to analyze the complex strain field at the nano-scale particle/matrix interface.
In this study, an innovative diffraction contrast imaging method derived from Ashby-Brown contrast is presented. Fast and statistical quantitative measurement is achieved on the interfacial misfit strain around nano-sized semi-coherent Y2Ti2O7 particles in austenitic oxide dispersion strengthened steel, where nano-sized oxide particles were formed. A much lower average lattice misfit strain of 1.6%, rather than 9.45% expected from lattices of matrix and precipitate crystals, was revealed by this method, and confirmed with HRTEM. It illustrated that the nano-scale interfacial strain could be measured by measuring the inter-spacing between the so-called "no-contrast" lines, and the misfit dislocations around a large number of particles could be revealed by a single bright field TEM image. A correlation between nano-scale interfacial strain and the measurable TEM fringes was set up.
The mechanism of the measurement lies on the symmetry of the strain field at specific orientations, which induces "no-contrast" lines on TEM images. This method is especially suitable for measuring misfit strain around semi-coherent particles that are smaller than 10 nm. This study is expected to bridge the gap between nano-scale interfacial structure and mechanical properties of materials that are strengthened by semi-coherent nano-particles.

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