

# Al-Fe B2 as a Model for Studying Defects and Long-Range Order in the AlCoCrFeNi Multicomponent Systems

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B2 alloys exhibiting ordered body-centered cubic (BCC) structures have been extensively studied for their potential in high-temperature and corrosive environments. However, their use is hindered by inherent brittleness at room temperature. In the past decade, there has been renewed interest in B2 structures due to their role in BCC-based multicomponent alloys, such as AlCoCrFeNi, where antiphase boundaries (APBs) have been found to reduce strain in the B2 matrix and suppress the formation of the embrittling phases [1,2]. Consequently, understanding and promoting these structural defects is crucial for improving the properties of these alloys.

Current research focuses on Al-Fe B2 phases, which have proven to be prototypes of the AlCoCrFeNi matrix [3], aiming to understand and formulate the mechanisms of APB formation to control their appearance. Our study was carried out systematically, preparing and evaluating binary, ternary, and multicomponent Fe-Al alloys using both novel and classical transmission electron microscopy methods. As a result, comprehensive insights into APB behaviour as a function of composition and processing conditions were obtained, leading to valuable conclusions that facilitate defect engineering.

The study was performed on two independent tracks: evaluating the effect of composition and researching the impact of strain on the formation and stability of APBs in Al-Fe-based B2. A quantitative relationship between composition, long-range order (LRO) parameter, and APB formation was established in binary Fe<sub>50+x</sub>Al<sub>50-x</sub> B2 alloys, identifying a critical threshold value for APB stability [4]. The research revealed that disorder, specifically on the Al sublattice, promotes APB formation, as demonstrated through studies of (Al<sub>50-x</sub>Cr<sub>x</sub>)Fe<sub>50</sub> and (Fe<sub>50-x</sub>Ni<sub>x</sub>)Al<sub>50</sub> ternary systems [5]. Increased compositional complexity accelerated disorder and lowered the LRO threshold for APB formation. Deformation was also found to promote APB formation, with applied strain reducing order sufficiently to promote APB formation at compositions where APBs had not formed thermally.

A novel analytical method using the ratio of <111> to total dislocation density ( $\rho_{\langle 111 \rangle} / \rho_{\text{total}}$ ) as an indicator of disorder was developed and refined through the research. This methodology can be used to assess the order parameter in complex non-binary systems, such as multicomponent alloys, where computing this value is challenging and, in most cases, even impossible.

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