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CRYSTALLOGRAPHY OF PHASE TRANSFORMATIONS IN SOLIDS AND ITS APPLICATIONS

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Properties of materials are governed by their microstructures, which in turn are controlled by the phase transformations at a given composition. To obtain the desired microstructure, it is essential to understand the phase transformations that occur in the material. Crystallography of phase transformations defines the morphology of microstructures, explains the actual phase transformation process at an atomic level and describes the relationship between the new phase and the parent phase. Hence, the crystallography controls the final properties of materials. In the past decades, although a number of theories/models have been developed to understand the crystallography of phase transformations, none of them can be used to design new materials and processes until the edge-to-edge matching (E2EM) model became available [1]. Development of the E2EM model was based on the principles that the nature of a coherent or semi-coherent interface and the associated crystallographic relationships are governed by minimisation of interfacial energy between two crystals; and that the necessary and sufficient condition for minimisation of the interfacial energy is to maximize the atom matching. The best and most effective approach to achieve the maximum atom matching is the matching of atom rows that are close packed or nearly close packed and are contained in the matching planes that are arranged to meet in the "edge to edge" manner as shown in following figure.Major advantage of the E2EM model over all other previous models is its predictive capacity from the first principle. Thus, it can be used to design new alloys and processes. In this presentation, after briefly reviewing the success of this model in predictions of the crystallographic features of diffusion controlled phase transformations in solids [1], its applications in development of new and more effective grain refiners for cast metals, including magnesium alloys [2], zinc alloys [3] and steels [4], are introduced. Predictions of the textures and growth features of epitaxial growth and crystalline nanowires [5] are also presented.

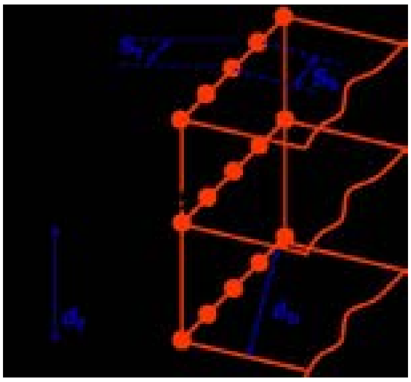

Figure: Schematic illustration of the edge-to-edge matching model

Recent Publications

1. Zhang M-X, Kelly P (2014) Crystallographic features of phase transformations in solids Progress in Materials Science, 54:1101-1170.
2. Ali Y, Qiu D, Jiang B, Pan F-S, Zhang M-X (2016) The influence of CaO addition on grain refinement of cast magnesium alloys Scripta Materialia, 114:103-107.
3. Liu Z-L, Qiu D, Wang F, Taylor J, Zhang M-X (2015) Crystallography of grain refinement in cast zinc-copper alloys. Journal of Applied Crystallography 48:890-900.
4. Li M, Li J, Qiu D, Zheng Q, Wang G, Zhang M-X (2016) Crystallographic study of grain refinement in low and medium carbon steels. Philosophical Magazine 96:1556-1578.
5. Liu Z, Zhang Z, Jiang R, Li X, Zhang M-X, Qiu D (2016) Crystallography of phase transformation in the self-inclined InAs nanowires grown on GaAs{111} Scripta Materialia, 121:79-83.

Biography

Professor Mingxing Zhang has his expertise in crystallography of phase transformations in solids and crystallography of grain refinement of cast metals. His research focuses on development of new metallic materials and their processing in order to improve the properties of the alloys. He is also an expert on surface engineering of engineering metallic materials. He is one of the two inventors of the well-known edge-to-edge matching model and proposes the research theme on crystallography of grain refinement for cast metals. He is currently a professor in materials science and engineering in the School of Mechanical and Mining Engineering, the University of Queensland. (orcid.org/0000-0001-8363-6968).

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