Interpretation of moire fringes in SEM observations for periodic microstructures

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Phase transformations in alloys and compounds frequently introduce periodic microstructures composed of multiple phases and/or surface reliefs. Under the specific SEM conditions, moiré fringes are observed in SEM images of the periodic microstructures. Despite the difference in morphology between the moiré fringes and the real microstructures, the moiré fringes are useful for analysis of the microstructures as has been reported elsewhere [1]. In the previous studies, however, only the moiré fringes related to artificial lattices have been discussed and, as far as the authors' knowledge, there are no detail report on the moiré fringes related to the real microstructures that have more complicated morphology than those of the artificial lattices. In this study, we characterize the moiré fringes in observations for a Ni-Mn-Ga ferromagnetic shape memory alloy and a Nb-TiCo pseudo-binary entectic alloy. The former exhibits periodic surface reliefs due to the martensitic transformation and the latter has periodic lamellar structure composed of Nb (bcc) and TiCo (B2) phases. Moreover, to understand the effect of observation conditions such as the acceleration potential and the detector geometry, model experiments using artificial lattices fabricated on a Si substrate are performed.

The results for Ni-Mn-Ga and Nb-TiCo alloys revealed that the moiré fringes show good agreements with the common theory of the moiré fringes. This means that the moiré fringes in the real microstructures are possible to be theoretically resolved and thus extended to applications such as strain mapping. On the other hand, the model experiments with the artificial lattices indicated that observation conditions such as the scanning speed influence the appearance of the moiré fringes. It is, therefore, important for applications to carefully select observation conditions to keep the moiré fringes compatible to the theory.

[1] S. Kishimoto, Theor. Appl. Mech. Lett. 2, 011001 (2012).

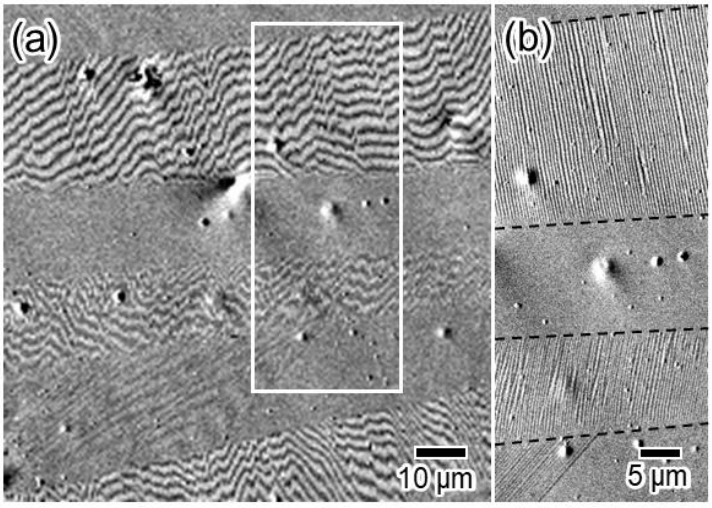

Figure (a) Moiré fringes in a Ni-Mn-Ga shape memory alloy. (b) High-resolution image showing the periodic surface reliefs.

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