

Correlation of mean inner potential depths at a SrTiO₃ bicrystal grain boundary annealed at different temperatures with thermal roughening transition

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Abstract:

By reconstructing exit face wave function using a set of defocused images, we have measured the projected mean inner potential depth at a grain boundary (GB) in a SrTiO₃ bicrystal. As annealing temperature increases, the potential depth at the grain boundary increases, which reveals an exponential profile. The free energy required to form a step on the crystalline smooth surface decreases with increasing temperature and it goes to zero at thermal roughening transition temperature, T_R . For crystalline surfaces, GBs are observed to undergo thermal roughening transition and can be correlated with defaceting transition [1]. Due to inherent electronic nature of the specimen, incoming electron experiences an electrostatic potential when it reaches a specimen. The volume average of the electrostatic potential within the material is termed as mean inner potential. Here the GB potential depth was determined by reconstructing exit wave function using a set of defocused images. From fig.1.(b), it can be found that there is a noticeably change in the GB potential depth between the specimens annealed at 1500°C and 1600°C with those as-received and annealed at 1000°C and 1300°C. The GB potential depth as well as its deviation begins to increase slowly from 1100°C to 1300°C, then increase abruptly between 1300°C and 1500°C, whereas its increase from 1500°C to 1600°C becomes gradual. The magnitude of the GB potential depth and its deviation indicates the degree of disorder of the GB. The tendency is consistent with the decreasing behavior of the GB step free energy with increasing temperature.

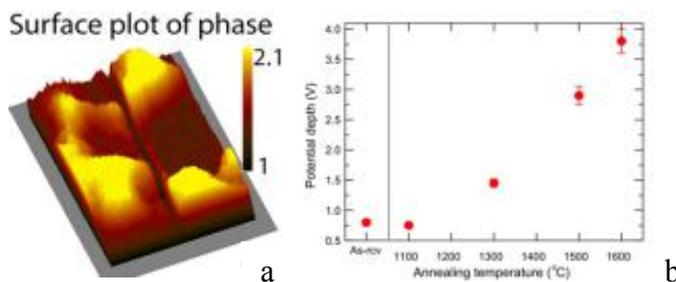


Figure 1: (a) Reconstructed surface plot of the reconstructed phase of the specimen as-received.

(b) Plot of the change in GB potential depth with increasing annealing temperature. 'As-rcv' in the x-axis label means the as-received specimen. The error bar is the standard deviation of the measurements for each temperature [2].

References:

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