Direct imaging of the disconnection climb mediated point defects absorption by a grain boundary

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Abstract

Grain boundaries (GBs) have been considered to be the effective sinks for point defects, which improve the radiation resistance of materials. However, the fundamental mechanisms of how the GBs absorb and annihilate point defects under irradiation at atomic scale are still not well understood. With the aid of the atomic resolution scanning transmission electron microscope (STEM), we experimentally investigated the atomistic mechanism of point defects absorption by a $\Sigma 31$ GB in α -Al₂O₃ under high energy electron beam irradiation. It is shown that a disconnection pair was formed, during which all the Al atomic columns were tracked by STEM imaging. We demonstrated that the formation of the disconnection pair is proceeded with disappearing of atomic columns in the GB core, which suggests that the GB absorbed vacancies. Such point defect absorption is attributed to the disconnection climb motion in mesoscopic scale. These experimental results provide an atomistic understanding of how GBs improve the radiation resistance of materials.

Full Text

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