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Effect of Annealing in a Helium Atmosphere on The Whisker Growth and Surface Degradation of Pristine and Cs-Implanted SiC

Silicon carbide (SiC) is a promising candidate for use as a first wall material in fusion reactors due to its high temperature stability and radiation resistance. However, during fusion, He gas is generated and collides with reactor wall materials, potentially affecting their structural integrity. In this study, SiC surfaces were investigated after annealing in both the vacuum and helium atmospheres. Two sets of SiC samples—pristine and those implanted with 300 keV Cs ions at room temperature to a fluence of 2×10^{16} cm^{-2}—were sequentially annealed in vacuum and He atmospheres from 800 ℃ to 1200 ℃ in 100 ℃ increments for 1 hour. Annealing in vacuum produced smooth surfaces for both sample types (i.e., pristine and Cs-implanted SiC samples), while annealing in He atmosphere led to the formation of whiskers on the surface. Notably, whisker growth was more pronounced on Cs-implanted samples, indicating that defects enhance the growth of whiskers. At 1200 ℃, partial sublimation of whiskers occurred, leaving voids on the SiC surface. These findings suggest that prolonged exposure to He at high temperatures may compromise the surface integrity of SiC, calling for a critical reassessment of its long-term viability as a first-wall material in fusion reactors.

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