Investigating the growth mechanisms of helium nanobubbles in silicon through spectrum imaging during *in situ* annealing.

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The properties of nano-scale defects such as rare gas bubbles in materials are extensively studied for both current and potential future purposes. Those range from the detrimental effects of alpha-particle irradiation in nuclear reactor walls, to the study of plasmonics and fluids at the nanometric scale.

Our purpose is to improve the understanding of the processes governing the evolution of He nanobubbles during thermal annealing by studying their inner fluid pressure and density, which are predominant factors in their behavior during growth.

We have developed a non-destructive and spatially-resolved approach for the He density determination using EFTEM instead of the STEM, a more common approach for spectrum acquisition. In our He-implanted Si samples, bubbles range from approximately 20 to less than 5 nanometers in diameter. Pixel per pixel, density and pressure maps can be obtained over several bubbles simultaneously, and mean pressure and size can be extracted for each of those. Using this procedure and *in situ* thermal annealing, experiments clearly show bubbles emptying between room temperature and 800°C, and movement and shape alteration in the same range. Acquisitions were performed with various annealing temperatures and time steps, allowing for the detailed study of the bubble behavior relative to those parameters.