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Electron Beam Artifacts in Liquid-Cell Electron Microscopy[1]
JOSEPH GROGAN, University of Pennsylvania, FRANCES ROSS, IBM T. J. Watson Research Center, HAIM BAU, University of Pennsylvania — Liquid-cell electron microscopy has recently emerged as a powerful technique for *in-situ* studies of nanoscale processes in liquids such as nanoparticles' formation, agglomeration, and oriented-assembly and electrochemical plating and imaging of the structure of macromolecules in their native environment. However, many of these phenomena are strongly influenced by the electron beam used for imaging, resulting in artifacts. To utilize the full potential of liquid cell electron microscopy, it is necessary to obtain a good understanding of the interactions of the electron beam with the imaged medium. This study explores the interactions of electrons with water, finding that radiolysis plays a key role in many studies while heating is typically insignificant. We derived a reaction-diffusion model to predict the concentration distribution of radiolysis products H, H_2, OH, H_2O_2, and hydrated electrons, and imaged homogeneous and heterogeneous nucleation of gas bubbles in the liquid cell. The presence of radiolysis products explains many of the observations of crystal formation, growth, and dissolution recently reported in the literature and observed in our laboratory. The study also suggests how to control electron beam effects to suppress or exploit them as desired.

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