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In-situ materials characterization at high spatial resolution: A journey through liquids, low temperature and beam damage.[1]

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The last few years have seen a paradigm change in the way we characterize materials, with unprecedented improvements in both spatial and spectroscopic resolution being realized by aberration-corrected transmission electron microscopes. While spatial and energy resolutions better than 60 pm and 10 meV have been reported, aberration-correction has also enables a large variety of in-situ experiments at close to atomic resolution. Using this approach, the intercalation of Li-ions into cathode materials, the dynamics of vacancies, and the interactions between gases and nano-particles can now be directly observed, to only mention a few examples. However, the electron probe current densities required for atomic-resolution imaging are often several orders of magnitudes higher than the threshold for electron-beam damage, which will prevent us from analyzing the true structure. Therefore, understanding and controlling the effects of the electron beam on the sample materials is emerging as one of the most important areas of current electron microscopy. Here, I will explore the effects of radiolysis by examining the mechanism of bubble formation in water encapsulated between two layers of graphene and focus on how to control the electron-dose rates and the formation of unwanted radicals in a liquid.

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