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Observations of Nanobubble Dynamics with Transmission Electron Microscopy MEERA KANAKAMMA MOHAN, MANISH ARORA, Division of Physics and Applied Physics, School of Physical and Mathematical Sciences, Nanyang Technological University, Singapore 637371, Singapore, UTKUR MIRSAIDOV, Mechanobiology Institute-Singapore, National University of Singapore, 5A Engineering Drive 1, 117411, Singapore, CLAUS-DIETER OHL, Division of Physics and Applied Physics, School of Physical and Mathematical Sciences, Nanyang Technological University, Singapore 637371, Singapore — Recent developments in transmission electron microscopy (TEM) allow the imaging of liquids with high spatial resolution. Here we report on novel studies of water trapped between two monolayers of graphene sheets. The geometry prevents evaporation of the liquid into the low pressure environment of the TEM while providing excellent electron-optical properties for investigations. The graphene sheets are supported by a conventional TEM grid. We report on the nucleation of bubbles, the coalescence between neighbouring bubbles, rupture of thin liquid filaments, and their slow shrinkage. At a dose rate of 100-155 $e^{-}Å^{-2}s^{-1}$ these events are observed conveniently at video frame rate. The correlation with the local electron beam dose rate suggests that the radiolysis induced by the electron beam is the main driving force for most events. In general, we observed bubbles with lateral sizes between 20nm and 100nm and estimated heights between 6nm and 30nm. Likely, the bubbles connect both graphene sheets. In the absence of the electron beam the nanobubbles do not dissolve completely but surprisingly remain stable for even up to one hour. This resembles the stability of surface attached nanobubbles.

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