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Electron irradiation effects in two-dimensional materials

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Abstract:

Nano-engineering of two-dimensional materials is becoming more and more important because it allows tailoring their material properties. This is crucial in order to expand the usage of two-dimensional materials in practical applications. One possible approach to induce structural changes is using electron microscopes as they are capable of confining irradiation effects to the sub-nanoscale due to the small electron wavelengths. Hence, a detailed understanding of the interaction between electron and material is needed to allow the best possible control. First, purely elastic processes were studied using graphene as a specimen. It was confirmed that the creation of elastic damage is a Poisson process. Additionally, chemical effects in electron microscopes were studied, showing that pristine graphene is inert to etching by air, but at defect sites, oxygen is the most effective etchant of air constituents. This effect was used to study pore growth under oxygen atmosphere in graphene. It became evident that the chemical reactivities for various edge structures are different, which could be utilized in the lithographic fabrication of graphene nanoribbons. Finally, an investigation of inelastic damage in hexagonal boron nitride was conducted. Revealing the mechanisms causing inelastic damage could allow the development of strategies to reduce specimen damage when imaging affected structures.