Manipulation and characterization of graphene using atomic force microscope

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Monolayer graphene is one of the most interesting materials applicable to next-generation electronic devices due to its distinctive carrier transport properties. However, realization of graphene devices requires suitable nanoscale lithography as well as a method to open a band gap in monolayer graphene. Nanoscale hydrogenation and oxidation are promising methods to open an energy band gap by modification of surface structures and to fabricate nanostructures such as graphene nanoribbons (GNRs). Until now it has been difficult to fabricate nanoscale devices consisting of both hydrogenated and oxidized graphene because the hydrogenation of graphene requires a complicated process composed of large-scale chemical modification, nanoscale patterning, and etching. I will report on nanoscale hydrogenation and oxidation of graphene at room temperature and atmospheric pressure without etching, wet process, or even any gas treatment by controlling just an external bias through atomic force microscope lithography.[1]

On the other hand, graphene produced by mechanical exfoliation has not been able to provide ideal performance comparable to that predicted by theory, and structural and/or electronic defects have been proposed as one cause of inferior performance. I will report the observation of domains on exfoliated monolayer graphene that differ by their friction characteristics, as measured by friction force microscopy.[2] Angle-dependent scanning reveals friction anisotropy with a periodicity of $180^\circ$ on each friction domain. The friction anisotropy decreases as the applied load increases. It is proposed that the domains arise from ripple distortions that give rise to anisotropic friction in each domain as a result of the anisotropic puckering of the graphene
