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Current and voltage dependent interactions between a scanning tunneling microscopy tip and a freestanding graphene sample

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The two dimensional nature of graphene gives rise to a number of unique properties. Chief among them are the ability to manipulate the electronic properties using mechanical deformations, opening a new field of "straintronics." Previous work from our group demonstrated the ability to manipulate a freestanding graphene sample with atomic precision using electromagnetic manipulation scanning tunneling microscopy (EM-STM). In the EM-STM technique, the tip bias is ramped over a predetermined range while maintaining a constant tunneling current. The resulting change in height of the tip is then recorded. Typical EM-STM measurements show quick movement of the sample between 0.1-1.0 V, and then slower movement after this point. The height of this final plateau is dependent on the tunneling current. To look for the cause of this current dependence $z(I)$ curves taken at a constant tip bias were examined. It was found that at low tip bias (0.1-0.5 V) the sample drops between 10-20 nm, while at high tip bias (1.0-3.0 V) the sample only drops 2-3 nm. This current dependence is attributed to a drop in the electrostatic force as the tip approaches the sample and holes in the benzene rings become more important.

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