

Effect of Strain on Chemical Reactions on Flexible Graphene Substrates

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Control over chemical reactivity is a central topic in the field of surface science. Graphene is a two-dimensional atomic sheet of sp^2 hybridized carbon with exceptional properties that can be altered by chemical functionalization. When mechanical strain is applied to the graphene lattice distortion leads to the electronic structure being altered. The effect of strain has been previously investigated, specifically for polycrystalline graphene, as domain boundaries can strongly affect the properties [1, 2]. Chemical functionalization can also be used to dope graphene as well as introduce a band-gap. Recently, it has been theoretically calculated that the distortion of the graphene lattice can lead to increased chemical reactivity for simple molecules such as hydrogen or metal nanoparticles [3, 4].

In this work, we investigate the effect that mechanical strain has on the reactivity of polycrystalline CVD grown single-layer graphene in electron transfer chemistry with aryl diazonium molecules. We found that mechanical strain can be used to alter the lattice structure of graphene, and increase the reaction rate by up to a factor of 10. Both the rate and final degree of reactivity were significantly increased upon the addition of mechanical strain, demonstrating a simple method for tuning the electronic properties of graphene. Theoretical calculations were also performed to support the experimental findings, and explain this impressive reactivity behavior. Our findings offer a new and simple approach to control the chemical reactivity of graphene through the application of mechanical strain, allowing for a tuning of the properties of graphene.

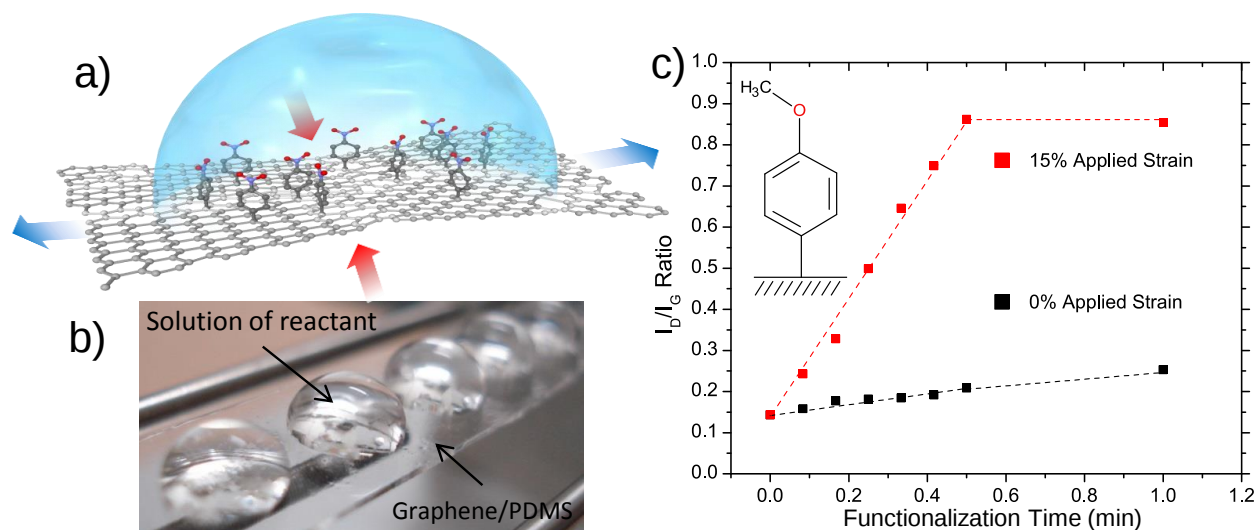


Figure 1: (a) Schematic depicting the chemical functionalization of mechanically strained graphene by an aqueous solution of aryl diazonium molecules. (b) Photo showing graphene on a flexible PDMS substrate being functionalised by droplets of diazonium solution. (c) Plot of I_D/I_G ratio, indicating degree of functionalization, showing increased reactivity of strained graphene compared to relaxed graphene.

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References

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