Contacting atomically well-defined graphene nanoribbons with atomic scale precision

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Abstract
Graphene nanostructures, where quantum confinement opens an energy gap in the band structure, hold promise for future electronic devices. Realizing novel functions will require exquisite, atomic scale control over the contacts to graphene and the graphene nanostructure forming the active part of the device. The contacts should have a high transmission and yet not modify the electronic properties of the active region significantly to maintain the potentially exciting physics offered by the nanoscale honeycomb lattice. Here, we show how contacting an atomically well-defined graphene nanoribbon (GNR) to a metallic lead by a chemical bond via only one atom significantly influences the charge transport through the GNR but does not affect its electronic structure. We form atomically well-defined contacts between the GNR and the gold substrate by removing individual hydrogen atoms from the end of a GNR. We use combined AFM and STM to link the changes in the chemical structure to the changes in the electronic properties. The dramatically increased coupling between the GNR and the lead manifests itself through the suppression of inelastic transport channels. The experiments are in a perfect agreement with the theoretical calculations.

References

[1] Joost van der Lit, Mark P. Boneschanscher, Daniël Vanmaekelbergh, Mari Ijäs, Andreas Uppstu, Mikko Ervasti, Ari Harju, Peter Liljeroth, Ingmar Swart', Submitted (2013).

Figures

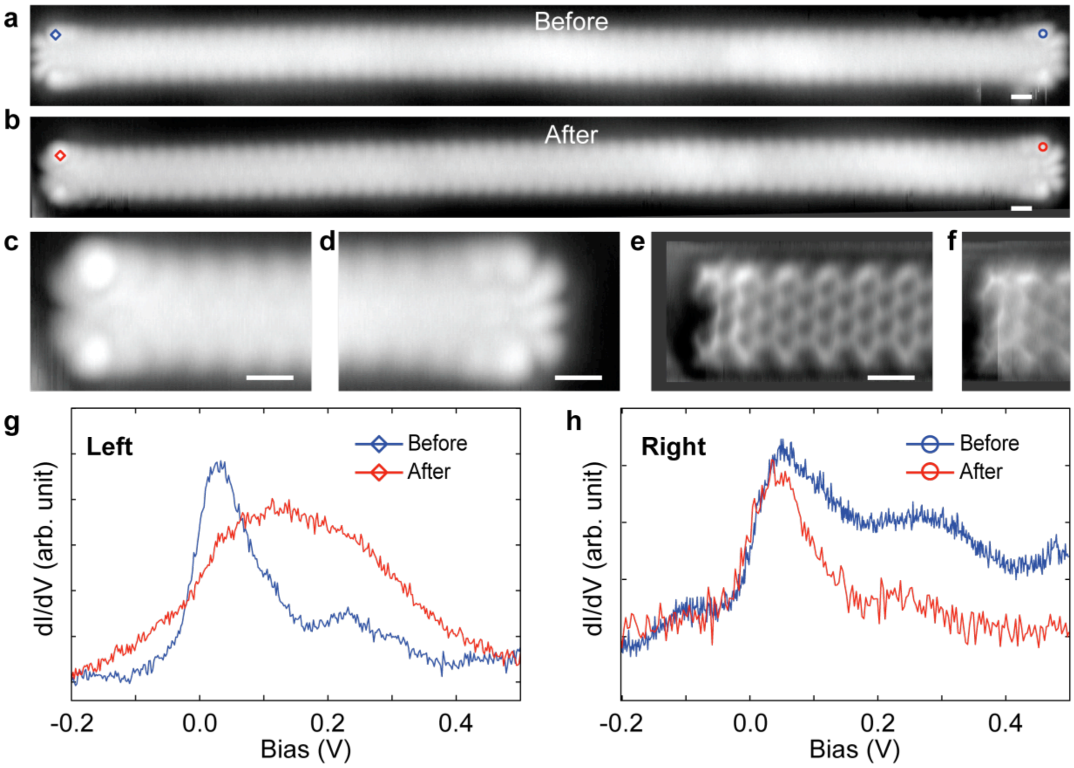

Figure 1 | Controlled atomic scale modification of the GNR reduces vibronic coupling. **a**, High-resolution STM image of a free GNR (V = 50 mV, I = 5 pA). **b**, High-resolution STM image after a bias pulse has been used to modify the left end of the GNR (V = 50 mV, I = 20 pA). **c**, **d** Zoomed-in STM images of the GNR ends after the modification (c: V = 50 mV, I = 50 pA, d: V = 10 mV, I = 2 pA). **e**, atomically resolved AFM image of the contacted GNR. **f**, AFM image of the same ribbon as in (e), but with the tip 80 pm closer to the sample. **g,h** d*I*/d*V* spectra recorded at the left and right ends of the GNR before (blue) and after (red) of the modification. All the images have been acquired with a CO-terminated tip. Scale bars: 0.5 nm.