Structure-property relation in atomically precise graphene nanoribbons on Au(111).

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Graphene nanoribbons (GNRs) are narrow stripes of graphene, whose electronic properties strongly depend on their detailed structure. As an example, GNRs with armchair shaped edges are predicted to be semiconducting, with a width-dependent band gap, while those with zigzag shaped edges are predicted to be semi-metallic and present localized spin-polarized edge-states [1]. Such variety of electronic behaviors places them as promising building blocks in next-generation nanoelectronic and optoelectronic devices. However, since the electronic properties of GNRs are highly susceptible to minimum changes in their structure, their precise synthesis and consequently the experimental confirmation of the predictions has remained a key challenge. Recent advances in bottom-up synthesis have shown that the growth of atomically precise GNRs can be produced by pre-designing the chemical structure of molecular precursors [2].

By means of low-temperature Scanning Tunneling Microscopy (STM) and Spectroscopy (STS), we report the study of different GNRs synthesized on Au(111) from two organic precursors: 4,4''-dibromo-*p*-terphenyl (DBTP) and 2,2'-dibromo-9.9'-bianthracene (DBBA). In the case of DBTP molecules, carefully annealing-triggered molecular reactions (Fig. 1a) result in the formation of GNRs with different width on the same metallic substrate (Fig. 1b,c) [3], enabling us to study the predicted band gap dependence of armchair nanoribbons on their width. Our results confirm this size dependence in armchair shaped GNRs and are in good agreement with calculations [4]. In turn, the use of DBBA molecules leads to the synthesis of well-defined, chiral nanoribbons (Fig. 2) with a consequently lower bandgap. Fourier-transform STS analysis provides additional insight into the GNR's band dispersion.

References

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Figures:

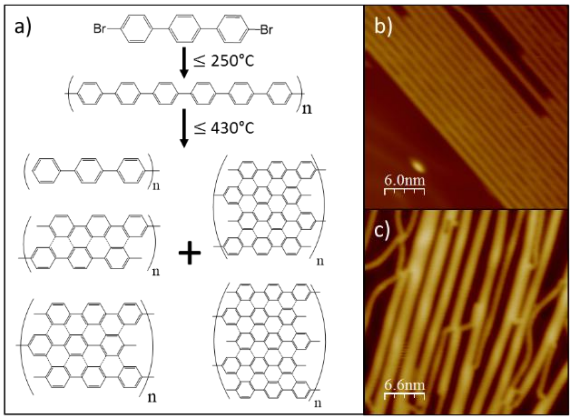

Figure 1. a) Synthesis scheme of DBTP nanoribbons. Topographic images of poly-p-phenyl wires and c) interlinked GNRs with different width.

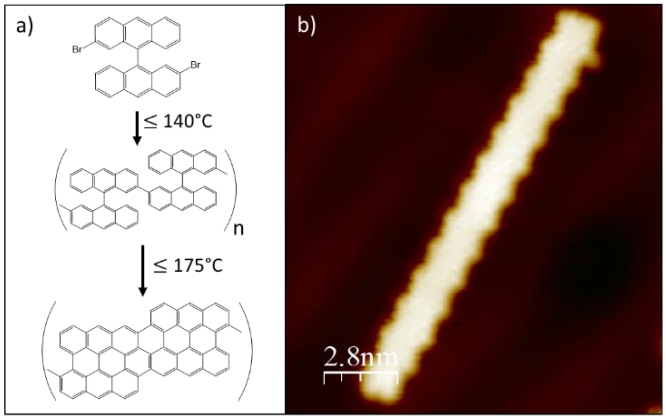

Figure 2. a) Synthesis scheme and b) topographic image of DBBA nanoribbons.