Mapping the slow-decay of end states in a laterally extended graphene nanoribbon

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End states (ESs) of quasi one-dimensional (1D) graphene nanoribbons (GNRs) have become a central focus in recent years because of their inclusion into the classification of topological tailor-made quantum systems.[1] So far, the topological phases of the GNRs are solely characterized by an integer parameter, called Z_2 invariant originating from the Zak phase, which takes values of 0 or 1 corresponding to topologically trivial or nontrivial configurations, respectively.[1] In these calculations, an infinite nanoribbon is always considered after defining the unit cells structure long the ribbon.[2] However, finite length nanoribbons are mainly observed and characterized experimentally. The tracking of the step-by-step building-up of ESs from a few unit cells to the formation of desired 1D/quasi-1D GNR molecular wire electronic band structure remains elusive. Combining picometer scale precision scanning tunneling microscopy, dI/dV spectroscopy mapping (STM and STS) with topological Hückel molecular orbital (HMO) calculations, we explain how topological quantum states are emerging or not with respect to the length 'N' (number of repeating molecular units) of the GNR starting from the basic polyene to the 1D polyacetylene chain and by a step-by-step enlargement of the nanoribbon width.

References

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