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Efficient manipulation of zigzag and armchair edges in graphene nanoribbons by joule heating XIAOTING JIA, MARIO HOFMANN, VINCENT MEUNIER, BOBBY SUMPTER, JESSICA CAMPOS-DELGADO, JOSE ROMO-HERRERA, HYUNGBIN SON, YA-PING HSIEH, ALFONSO REINA, JING KONG, MAURICIO TERRONES, MILDRED DRESSELHAUS — Edge study in graphene nanoribbons has attracted lots of interest in recent years, due to the different electronic properties of the ribbons arising from zigzag and armchair edges. Here we demonstrate and monitor an efficient crystallization process for graphite nanoribbon edges by Joule heating inside an integrated transmission electron microscope (TEM) equipped with a scanning tunneling stage STM (TEM-STM system). With this system we were able to produce for the first time atomically smooth zigzag or armchair edges from defective rough edges present in graphite nanoribbons, by applying a controlled voltage, while observing the structural behavior in-situ. Edge motion along certain preferred crystallographic orientations is observed, and the transformational effects of Joule heating and applied electric field are described. This work demonstrates both the possibility of self-eliminating lattice defects by applying a bias voltage, and an effective way to produce clean zigzag and armchair edges, which could be useful for both fundamental studies of edge reactivity, magnetism and the development of future electronics applications.

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