Achieving edge-closed graphene nanoribbons by squashing carbon nanotubes

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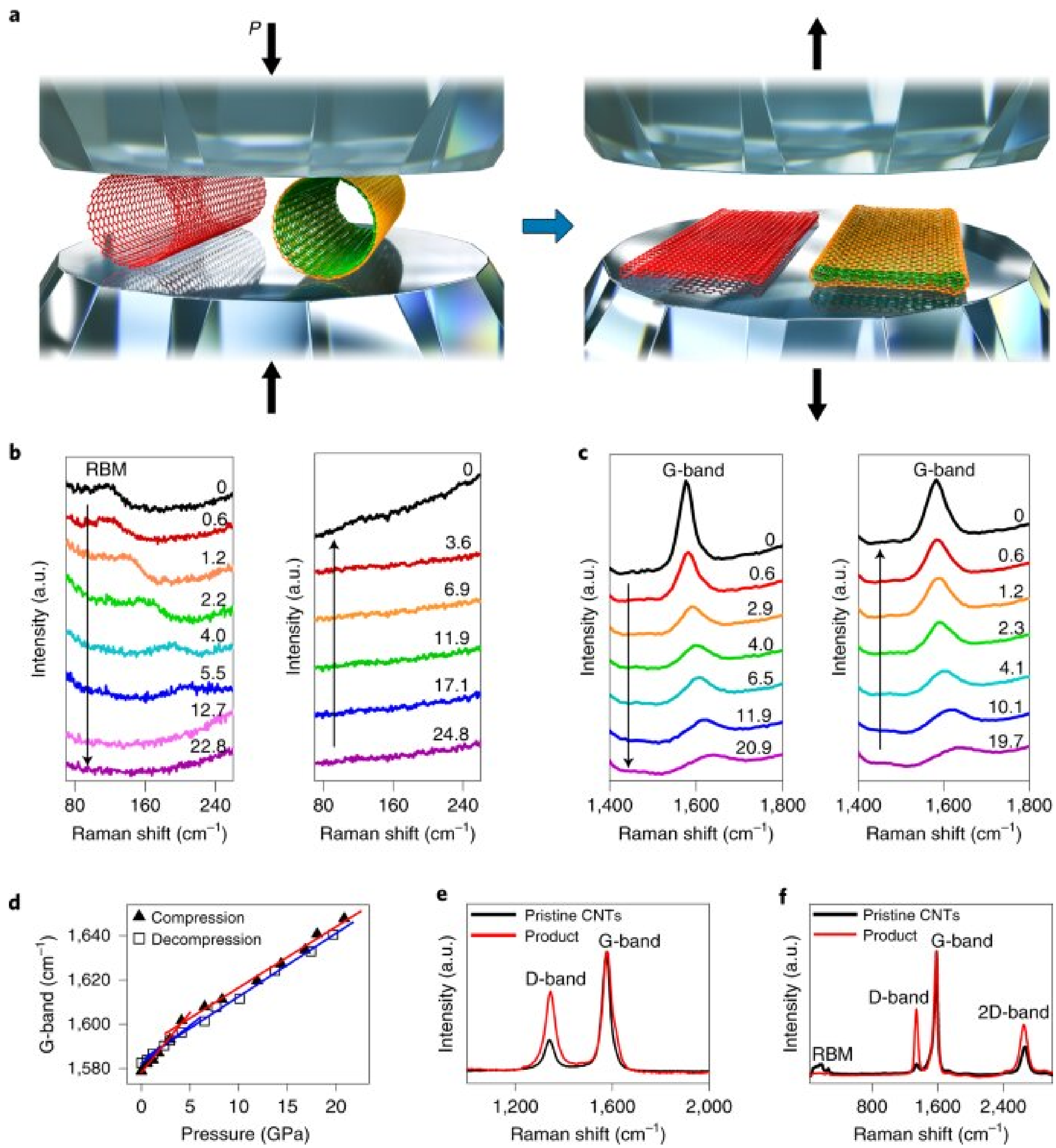

Credit: DOI: 10.1038/s41928-021-00633-6

Long, narrow graphene nanoribbons (GNRs) with smooth edges, sizable bandgap and high mobility are highly desirable for electronic and optoelectronic applications. However, efficiently preparing such GNRs is difficult. Recently, Changxin Chen and his colleagues report that sub-10-nm-wide semiconducting graphene nanoribbons with atomically smooth closed edges can be produced by squashing carbon nanotubes using a high-pressure and thermal treatment. The study was published online September 6 in *Nature Electronics*.

One major obstacle to the application of graphene in electronics and optoelectronics has been that two-dimensional graphene is a semimetal with the zero bandgap. One solution is to use one-dimensional graphene nanoribbons (GNRs) with a narrow width. Previous studies had demonstrated that the GNRs with a width of 10^4), on-state conductivity (7.42 mS) and device mobility (2,443 cm^2 V^−1 s^−1) achieved concurrently. And a bandgap of ~494 meV is estimated for this GNR. High-yield synthesis of narrow semiconducting GNRs with high mobility and sizable bandgap is crucial for its large-scale device integration.

The method in this work provide a route to produce high-quality, narrow, and long semiconducting GNRs and to control the GNR's edge types for exploring their fundamental properties and practical applications in electronics and optoelectronics. It is a significant advance in the production of high-quality GNRs and high-performance GNRFETs. "Comparing with the methods reported earlier, this new approach is capable of producing much narrower GNRs," Changxin Chen said. "Moreover, the atomically smooth edges throughout the entire GNR can be achieved by our method, resulting in high material and device mobility."

"Taking advantage of our method's high yield, it is hopeful to scale up the synthesis by further using a multi-anvil apparatus or a large-volume press. Importantly, this method can also be extended to make other material-based nanoribbons from squashed nanotubes and to flatten other fullerene materials," said Changxin Chen.

More information: Changxin Chen et al, Sub-10-nm graphene nanoribbons with atomically smooth edges from squashed carbon nanotubes, *Nature Electronics* (2021). DOI: 10.1038/s41928-021-00633-6

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