UNIVERSITÄT DUISBURG ESSEN

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UDE: 2D Material withstands extremely high current densities

Graphene under Fire

The particle penetrated the ultra-thin sample with speeds of up to 450 km/s, yet everything stayed in one piece: This is what happened to a team of international scientists, among them Professor Dr. Marika Schleberger from the Center for Nanointegration (CENIDE) of the University Duisburg-Essen (UDE). Her sample of freestanding graphene was able to balance out the charge of a high-energy ion within femtoseconds and thus prevent a nanoscale explosion. "Nature Communications" reported on this in its latest issue.

Freestanding graphene is very difficult to prepare and stabilize, which is why the leading workgroup of the TU Wien turned to UDE physician Marika Schleberger: Her team members Roland Kozubek and Anke Hierzenberger accomplished the feat of transferring, almost defect-free, the 2D material without a stabilising base onto a grid of gold bars. The grid's interstices of approximately 1.2 micrometre in diameter allowed the single layer of free-floating carbon atoms to be investigated.

The experiments took place at the Helmholtz-Zentrum Dresden-Rossendorf. It was demonstrated here that, unlike other carbon atom sheets, graphene is capable of guiding negatively-charged electrons within a billionth of a second to a position where a very positively-charged ion is approaching. Even before the impact, it balances the charge out and prevents a mini explosion, which would significantly damage the material. Investigations in the Interdisciplinary Center for Analytics on the Nanoscale (ICAN) at the UDE were able to prove this with a picture: high-resolution microscopy makes individual carbon atoms visible and reveals a completely intact grid both before and after the ion bombardment.

"That was a surprise for us," reports Schleberger, "Graphene evidently tolerates current densities three-times higher than previously thought." In the next step, she wants to investigate how other 2D materials and multi-layers react to an ion bombardment.

An international team of experimental physicists and theoreticians collaborated for the publication in "Nature Communications".

Picture caption:
Electron microscope image shows the undamaged graphene grid even after the ion bombardment. The honeycomb structure of six carbon atoms can be clearly seen in the high-resolution.

Original publication:
E. Gruber, R.A. Wilhelm, R. Pétuya, V. Smejkal, R. Kozubek, A. Hierzenberger, B.C. Bayer, I. Aldazabal, A.K. Kazansky, F. Libisch, A.V. Krasheninnikov, M. Schleberger, S. Facsko, A.G. Borisov, A. Arnau, F. Aumayr: „Ultrafast electronic response of graphene to a strong and localized electric field", Nature Communications 7, 13948 (2016)
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