Single polymer chains as molecular wires

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The research team of Leonhard Grill at Freie Universität Berlin - in collaboration with the synthetic chemistry group of Stefan Hecht from Humboldt University of Berlin and the theoretical physics group of Christian Joachim of the CEMES-CNRS institute in Toulouse - has succeeded in lifting single polymers from a gold surface, similar to chains, and in measuring their electrical and mechanical properties during this process. The scientists place one end of a polymer strand in contact with a metallic tip, thereby inducing an electrical current through single molecular wires over extraordinarily long distances during the pulling process. The results were published in the most recent issue of *Science*.

A central vision of nanotechnology lies in the construction of electronic circuits on the nanometer scale. The development of such fascinating devices, which would revolutionize many applications, requires molecular "cables" and a detailed understanding of electrical transport through such small wires. Thus, it is necessary to determine the electrical current through a single molecular wire, contacted to two electrodes, as a function of its length. Up to date, only relatively short wires with a fixed length have been investigated, and most of the studies were based on statistical measurements, making the exact characterization of a single wire impossible.

The molecular wires were constructed by connecting single molecules on a gold surface to a polymer chain. After one end of the chain was contacted with the tip, the other end remains on the metal surface and the distance between the two electrodes (tip and surface) is varied continuously during the pulling of the polymer. Using this method, it was possible for the first time to measure the charge transfer through a single polymer for different lengths of up to more than 20 nanometers. These experiments provide insight into the electrical properties and also into the mechanical characteristics of single polymers, which behave like macroscopic chains as one chain unit after another is detached from the surface during the pulling process.

The electrical transport on the level of single molecular wires is of great importance for any electronic application in molecular nanotechnology. In the reported experiments it was possible for the first time to characterize the dependence of the electrical conductance on the length of the molecular wire and its mechanical properties. In the future, using this method, it should be possible to optimize molecular wires with respect to their suitability for applications.

More information: L. Lafferentz, F. Ample, H. Yu, S. Hecht, C. Joachim, L. Grill, "Conductance of a Single Conjugated Polymer as a Continuous Function of Its Length", *Science* (Feb. 27, 2009); Internet: www.sciencemag.org/

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