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Puzzling Electrical Conduction in a Synthetic Single-Layer Material

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Streszczenie:

Interfacial electron beam lithography (IEBL) is a novel chemical patterning methodology that enables nondestructive local functionalization of the outer surfaces of highly ordered n-alkylsilane monolayers on silicon via chemical conversion of their top -CH_3 groups to -COOH while fully preserving the overall molecular organization and structural homogeneity of the monolayer. IEBL-fabricated channels consisting of ionizable -COOH surface paths with precisely defined micrometer-to-centimeter lengths and widths down to less than 20 nanometers exhibit unusual lateral electrical conduction, dependent on their dimensions, the nature of the metal electrodes contacting the channel, the type and conductivity of the underlying silicon substrate, the nature and thickness of the insulating spacer between the channel and the silicon surface, and the presence and nature of a top cover layer. The interplay between these system parameters allows modulating the conductivity of a given channel between that of a practical insulator to some abnormally high values. Empirical correlations based on a comprehensive characterization methodology that combines electrical measurements with multi-mode AFM imaging, quantitative IR and micro-IR measurements, and post-patterning chemical derivatization and nanoscale self-assembly capabilities point to a complex conduction mechanism that involves coupled ionic-electronic transport mediated and enhanced by interfacial electrical interactions with charges located outside and separated from the channel carrying the measured current. These unprecedented findings may not be rationalized based on known charge transport mechanisms.

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R. Maoz, J. Berson, D. Burshtain, P. Nelson, A. Zinger, O. Bitton, J. Sagiv. Interfacial Electron Beam Lithography: Chemical Monolayer Nanopatterning via Electron Beam-Induced Interfacial Solid-Phase Oxidation. *ACS Nano* **2018**, 12, 9680-9692.

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