Novel Flexible Substrate-based 2D MoS2 Devices and Novel Ionic Liquid Gated MoS2 Field-effect Transistors on Flexible Substrates

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Flexible two-dimensional (2D) field-effect transistors (FETs) have gathered great interest, due to the need to solve scalability problems that are commonplace in 3D FETs. Specifically, the replacement of rigid substrates with flexible materials, along with the usage of transition metal dichalcogenides (TMDCs) with strain-resistant and excellent electrical characteristics has led to an interest in developing 2D FETs utilizing elastomer and polymer-based materials such as polydimethylsiloxane (PDMS) and polyethylene terephthalate (PET). Herein, we demonstrate the feasibility of using PDMS as a substrate for multilayer MoS2-based devices, utilizing polymers polypropylene carbonate (PPC) and poly(methyl methacrylate) (PMMA) as means of facilitating transfer of mechanically exfoliated MoS2, obtaining high output current (maximum ~ -0.65–0.55 μA μm^-1), ohmic behavior, and low contact resistivity. Further, we demonstrate the ability for polymer PET to be utilized as a flexible substrate for multilayer MoS2-based FETs, with devices exhibiting transfer characteristics comparable to rigid MoS2 FETs in literature, showing acceptable field effect mobility (1.53–14.39 cm^2 V^-1 S^-1), good on-off ratios (maximum ~1 x 10^5), and acceptable subthreshold slope (minimum average 371.48 mV dec^-1), via utilizing novel ionic liquid N,N-diethyl-N-methyl-N-(2-methoxyethyl)ammonium bis(trifluoromethanesulfonyl)imide ([DEME][TFSI]) through ionic liquid gating (ILG). The work presented here is one of the first in demonstrating the feasibility of ILG on PET substrate-based FETs, demonstrates the alternative usage of PDMS as a substrate in 2D devices, and provides a platform for the incorporation of ILG as a means of gating in flexible 2D FETs in the future.

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