Investigating MoS_2/Au interaction by nanoscale force spectroscopy for resistive switching applications

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The resistive switching effect is the ability of a material to reversibly change its conductivity after electrical stimulation. One of the main desirable applications for this phenomenon is the technology of non-volatile computer memory, where distinguishable conductivity states are representing logical states of a memory cell. Memory cells in resistive switching technology are simple MIM (metal/insulator/metal) structures, where switchable material is sandwiched between two metal electrodes. It is possible to change the resistance of an insulating material by polarizing it with external electric field, which results in a transition from a high resistivity state to a low resistivity state or vice versa. These states can represent logical states „0" and „1" which code information processed by computer algorithms. Promising group for this application are 2D materials which are now intensively studied due to their atomically thin structure, outstanding mechanical properties like Young's modulus and strength or electronic properties covering a wide range of applications from insulators to conductors or even superconductors. One of the subgroups of 2D materials are transition metal dichalcogenides which general formula is MX_2, where M is a transition metal and X is a chalcogen. Most widely studied transition metal dichalcogenide is MoS_2 due to its environmental stability and low temperature chemical vapor deposition synthesis.

The efficiency of devices made from 2D materials or their heterostructures relies highly on the quality of the material/substrate interface. Thus it is crucial to investigate the impact of substrate quality on the electronic performance of the devices and the physics of the material/substrate interaction. In our work interaction between MoS_2 and two different substrates was investigated. For samples production standard exfoliation procedure with the adhesive tape and low adhesive polymer was used. Samples with gold and silicon substrate were fabricated and examined with nanoscale force spectroscopy. Results show a modification of the MoS_2/Au interface. Applying certain force with a nanoprobe resulted in a change of the MoS_2 morphology which is probably caused by a strong MoS_2/Au interaction. For a comparative set of samples produced on silicon substrates this effect is not observed. Instead, applying force led rather to a small displacement of air bubbles trapped underneath the MoS_2 flake or to the flake tearing.

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