Flexible 2D Transistors and Solar Cells by Direct Transfer with Contacts

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We present our recent work on a new integration process for two-dimensional (2D) and layered transition metal dichalcogenides (TMDs) on flexible substrates. Our direct transfer approach can be applied for various TMDs synthesized by different growth methods and with a wide range of thicknesses. In short, we pattern TMD and Au metal contacts on rigid silicon substrates before spin-coating and curing the flexible target substrate on top. All structures can then be easily released in deionized water (Fig. 1) and further processing is performed on the flexible substrate. This method enables us to create TMD transistors with nanoscale channel lengths and record-high drive currents >300 µA/µm [1], comparable to flexible graphene or single-crystalline silicon transistors. We also use this method to fabricate flexible, light-weight TMD solar cells, where we employ graphene doped by molybdenum oxide as transparent top contact [2]. Our devices reach the highest power conversion efficiency (5.1%) and power-per-weight (4.4 W/g) reported for flexible TMD solar cells, comparable to prevailing thin-film photovoltaic technologies (e.g., III-Vs or copper indium gallium selenide). These results demonstrate the promise of 2D/layered TMDs for flexible (opto-)electronics and could lead to flexible self-powered electronic systems in the future.

References

[1] A. Daus et al., Nature Electronics, 4, (2021), 495-501.
[2] K. Nassiri Nazif et al., Nature Communications, 12, (2021), 7034.

Figures

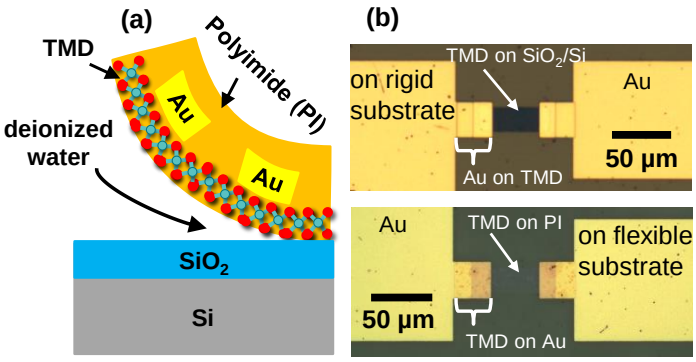

Figure 1: (a) Schematic direct transfer process of 2D TMDs with patterned Au contacts. The PI becomes the flexible substrate after release from the rigid SiO_2/Si. (b) Optical microscope images before and after the transfer. Note, different colors of TMD on Au are due to different Au thicknesses.