Novel functional transistors of transition metal dichalcogenide monolayers

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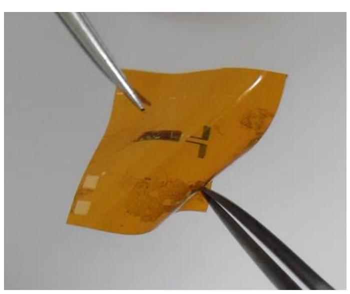
Recently, the transition metal dichalcogenide (TMDC) monolayers, such as MoS_2, $MoSe_2$ and WSe_2, have attracted considerable interest because of its high carrier mobility, mechanical strength, large intrinsic bandgap and optical properties [1,2]. Although many researches have been done by mechanically exfoliated TMDC monolayers, the CVD growth of TMDC thin films that could be transferred onto other arbitrary substrates was reported, thereby providing a path forward to develop large-area CMOS electronics built onto flexible plastic and stretchable rubber substrates [2-6].

Here, we firstly demonstrate the fabrication of CVD-growth MoS_2 thin-film transistors (TFTs) using ion gel as elastic gate dielectrics [5]. Because these transistors revealed good performance (mobility of 12.5 cm^2/Vs and On/Off ratio of 10^5), we transferred MoS_2 films on flexible plastic substrates and realized excellent flexibility down to a curvature radius of 0.75 mm [5]. We also fabricated MoS_2 transistors on stretchable rubber substrates and achieved high stretchability under 5% channel strain without significant degradation of the carrier mobility and on/off current ratio, which might be owing to a relaxation of ripples [6]. As the next step, we challenged to expand material variation and successfully fabricated high-performance CVD-growth WSe_2 transistors (mobility of 90 cm^2/Vs and On/Off ratio of 10^7) and simple resistor-loaded inverters [4]. Finally, by the combination of MoS_2 and WSe_2 TFTs, we also demonstrated TMDC CMOS inverters, opening a route for atomically thin electronics on flexible and stretchable substrates.



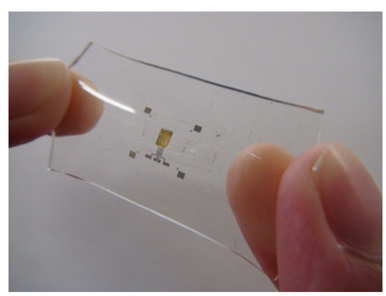


Figure. Pictures of flexible (left) and stretchable (right) MoS_2 transistors

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[2] Q. H. Wang *et al.*, Nature Nanotechnology 7, 699 (2012).
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[4] J.-K. Huang, T. Takenobu, L.-J. Li *et al.*, arXiv:1304.7365.
[5] J. Pu, L.-J. Li, T. Takenobu *et al.*, Nano Letters 12, 4013 (2012).
[6] J. Pu, L.-J. Li, T. Takenobu *et al.*, submitted.