Multiplexing Rubbing-Induced Site-Selective (RISS) Method for Manufacturing MoS_2 Device Arrays

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Transition metal dichalcogenides (TMDCs) have been exploited to make various prototype devices based on their superior electronic and mechanical properties.[1,2] Among all TMDCs, Molybdenum disulfide (MoS_2) has attracted huge attention because of its elemental abundancy, nontoxicity, and ease of synthesis. Pristine few-layered MoS_2 flakes are usually fabricated by mechanical exfoliation from bulk ingots or chemical vapor deposition (CVD) methods. However, to produce uniform arrays of nano/microscale devices, resist-based lithography and plasma etching needs to be applied onto such fragile 2D-layered materials, generating permanent contaminations and damages. Current standard cleaning methods for nanofabrication (e.g., piranha cleaning) cannot thoroughly eliminate such lithography-introduced contaminations without causing serious damages to the 2D device features. Such lithography-introduced contamination could greatly compromise the transport properties of the devices and increase device-to-device variations among the arrays. Our recent work demonstrated a rubbing-induced site selective (RISS) method capable of generating MoS_2 lines with no need of additional lithography or etching processes.[3] However, to make RISS suitable for practical nanomanufacturing implementation, additional processing science research needs to be performed to enable a multiplexing RISS technology capable of producing arrays of arbitrary 2D material device patterns.

In this paper, we report our recent progress in developing a multiplexing rubbing-induced site-selective (RISS) technology, which integrates site-selective growth scheme based on mechanically generated triboelectric charge and multiplexing rubbing templates driven by programmable 2D stages, capable of generating arbitrary MoS_2 pattern arrays on a substrate.

The present multiplexing RISS process includes two main steps: (i) rubbing wafer with a template bearing 2D pillars to predefine the locations and patterns of target MoS_2 device features on the substrate; (ii) site-selective CVD growth of monolayered MoS_2 patterns at the designated locations, ever rubbered by the pillars template. **Fig.1(a)** shows the schematic illustration of a rubbing template, and Figs. 1 (b) and (c) illustrate the basic RISS route for generating an array of MoS_2 device features on the target substrate. **Fig.2** shows the optical micrograph of a representative array of RISS-produced strip patterns of MoS_2.

This work could be further developed as a reliable nanomanufacturing method for generating miniaturized on-chip sensor array. Additional details of multiplexing RISS as well as device demonstrations will be presented in the formal presentation.

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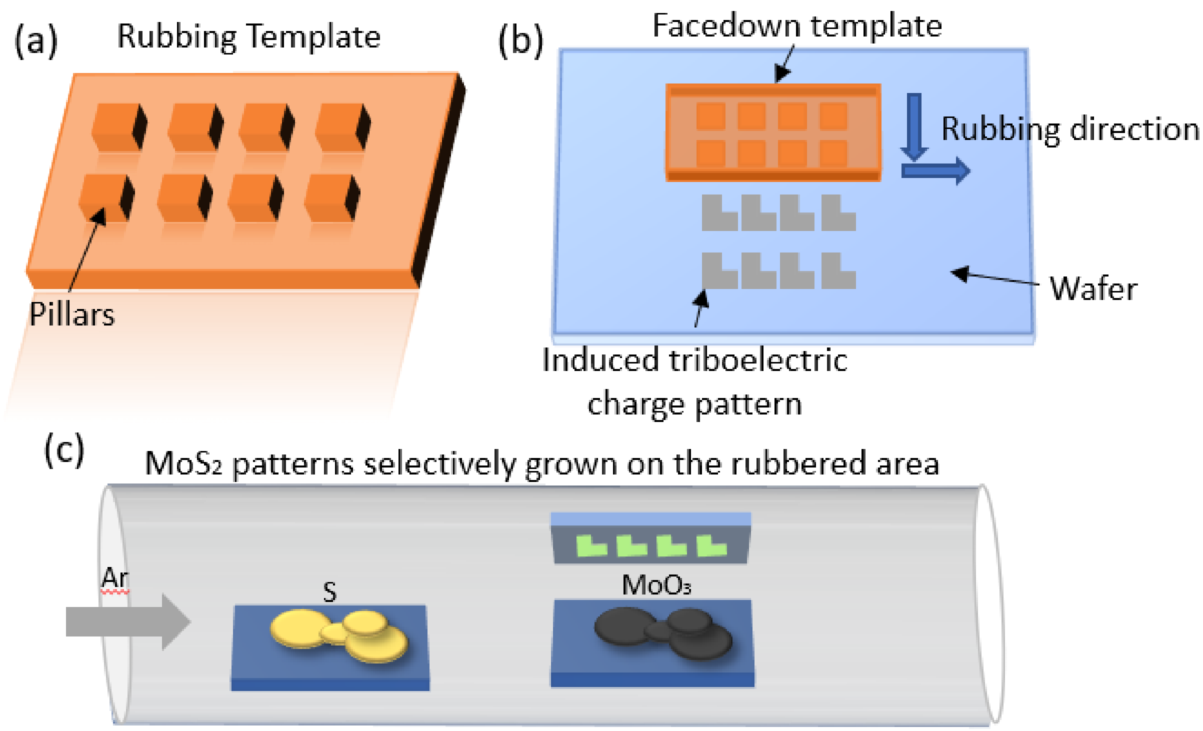

Fig.1 Schematic illustration of the multiplexing RISS method for site-selectively growing an array of MoS_2 device patterns on the target substrate.

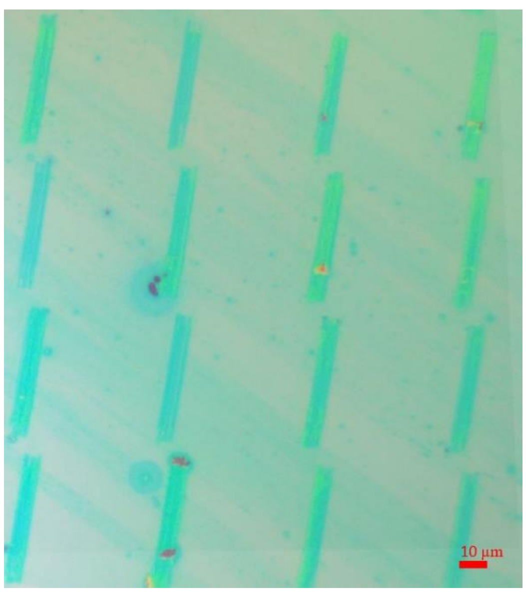

Fig.2 Optical micrograph of a representative array of RISS-produced MoS_2 strips with period of 80 µm. (scale bar: 10 µm)

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