Scalable and high-throughput 2D nanopatterning via sequential combination of continuous 1D patterning strokes

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Recently, 2-dimensional (2D) nanopatterns are being utilized in many fields including functional coatings, photonic films, and thin-film device components. As the demands for large-area nanophotonics and nanoelectronics are prevailing these days, relying on typical methods to fabricate 2D nanopatterns through laser interference and e-beam lithography are often limited in area and throughput.

To this end, we develop a simple but versatile methodology for scalable and high-throughput fabrication of 2D nanopatterns via sequential 1D nanopatterning strokes enabled by Dynamic Nano-Inscribing (DNI; Figure 1a) and Vibrational Indentation Patterning (VIP; Figure 1b). Since DNI can inscribe and VIP can indent 1D micro/nano-grating patterns continuously on any flexible substrates with period and depth control, various 2D patterns of desired topology can be continuously 'direct-written' by combining these 1D patterning strokes (Figure 1c). Further, by adopting the grating-containing DNI tool for VIP processing, a 'single-stroke' 2D patterning can also be realized (Figure 1d). More 2D patterns tuned by controlling DNI and VIP process parameters are to be presented.

Many applications can benefit from the presented 2D nanopatterning strategy, particularly requiring large area and high throughput. For instance, large-area light-scattering films can be made for improving efficiency of solar cells or light-emitting diodes. Also in bioengineering the well-defined 2D 'nanovoid' patterns can be capitalized as a size-selective sorting and locking of nanoparticles (NPs – mimicking various biological species such as circulating tumor cells). The exemplary and prospective applications will be demonstrated at the meeting.

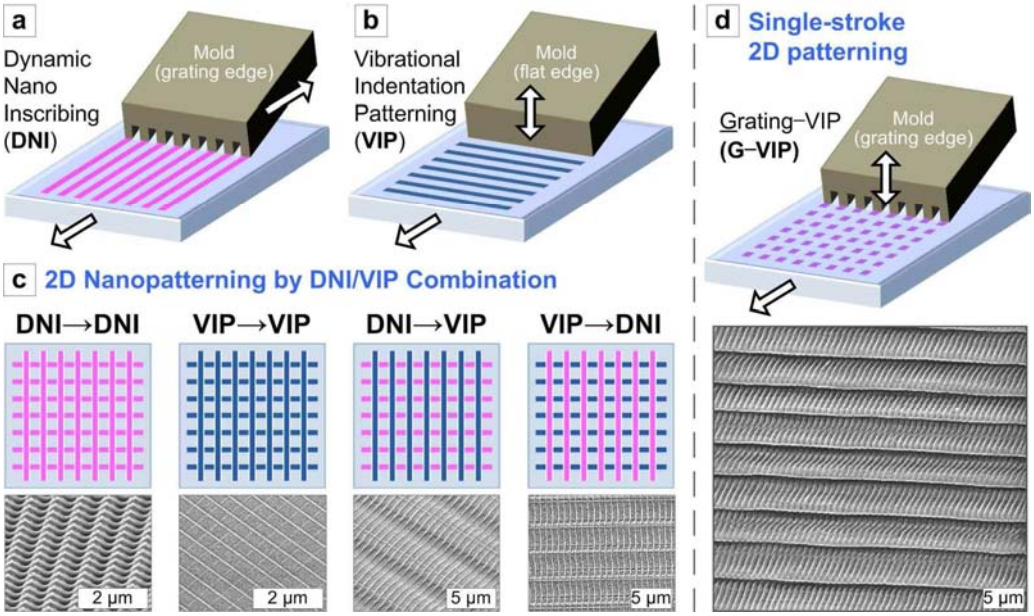

Figure 1: High-throughput fabrication of various 2D nanopatterns by combination of DNI and VIP: Schematic illustrations of (a) DNI and (b) VIP processes. (c) Scanning Electron Microscope (SEM) images of various 2D patterns created by DNI and VIP combinations. (d) Scheme (top) and representative SEM image (bottom) of a single-stroke 2D patterning where a grating edge is used for a vibrating tool.