4D Chemical Nanolithography

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Controlling the organization of biomaterials on surfaces with nanometer resolution is of paramount importance for fundamental biological, physical, and medical studies, and for the development of optical and electronic devices.[1] State of the art technologies for constructing materials composed of delicate organic and biologically active matter are based primarily upon ink-jet printing, pin-printing, whereas conventional photolithography is expensive and destructive. By marrying massively parallel scanning-probe based nanolithography approaches, specifically polymer-pen lithography (PPL) and beam-pen lithography (BPL), with surface organic chemistry, we have developed new approaches for preparing glycan arrays,[2] functionalizing graphene,[3] and creating brush polymer arrays.[4] Recently, combining massively parallel scanning probe nanolithography, microfluidics, and brush polymer chemistry, we have achieved 4D organic micromanufacturing, where the four dimensions are the 3 Cartesian coordinates (x,y,z) and the fourth is the chemical composition of each spot in an array.[5] This novel materials manufacturing approach could pave the way towards materials with the chemical and topological complexity common to biological interfaces.

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[3] Shudan Bian, Amy M. Scott, Yang Cao, Yong Liang, Sílvia Osuna, K. N. Houk, and Adam B. Braunschweig, Journal of the American Chemical Society **135**, 25, (2013).

[4] Shudan Bian, Sylwia B. Zieba, William Morris, Xu Han, Daniel C. Richter, Keith A. Brown, Chad A. Mirkin, and Adam B. Braunschweig, Chemical Science **5**, 5, (2014).

[5] Xiaoming Liu, Yeting Zheng, Samuel R. Peurifoy, Ezan A. Kothari, and Adam B. Braunschweig, Polymer Chemistry **7**, 19, (2016).

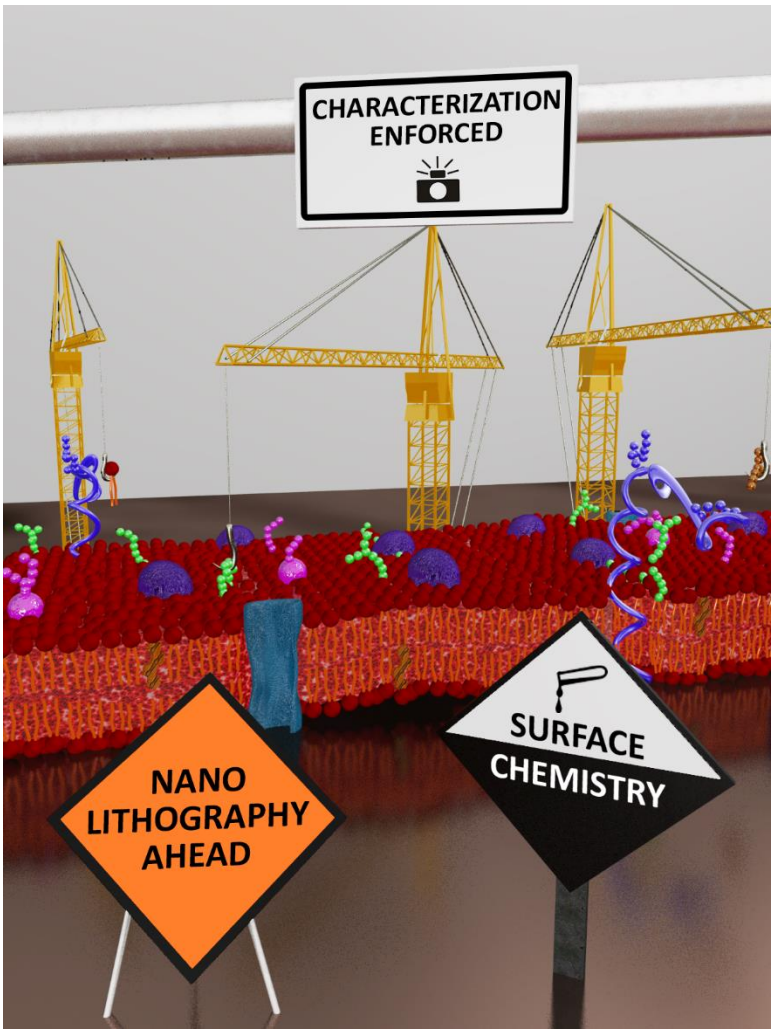

Figure 1: 4D Chemical Nanofabrication requires simultaneous advances in surface chemistry, soft-matter compatible deposition technologies, and surface characterization protocols.