

Mechanically-guided Assembly of 3D Mesostructures and Microelectronics

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Abstract: The development of strategies for forming 3D micro and nanostructures in advanced materials is of increasing interest, driven by the potential for creating material systems with fundamentally new characteristics and functionalities. Existing approaches of 3D assembly/fabrication, however, can only be used directly with a narrow range of materials and/or 3D geometries. A grand challenge in the field is in the development of schemes that allow construction of 3D structures in device-grade crystalline inorganic materials essential for high-quality electronic systems and MEMS. In this presentation, we introduce a mechanically-guided assembly approach that exploits controlled, compressive buckling, for constructing complex 3D micro/nanostructures rapidly from patterned 2D micro/nanoscale precursors. This approach applies to a broad set of materials (e.g., semiconductors, polymers, metals, and ceramics) and even their heterogeneous integration, over a wide range of length scales (e.g., from 100 nm to 10 cm). To provide theoretical guidelines of the buckling-guided 3D assembly, we established a series of mechanics models for the postbuckling analyses. The compatibility of the approach with the state-of-the-art fabrication/processing techniques available in semiconductor industries, along with the versatile capabilities, allow transformation of diverse existing 2D microsystems into 3D configurations, providing unusual design options in the development of new functional devices. We will demonstrate a few examples in this presentation, including tunable integrated electronics, wearable electronic systems, reconfigurable antennas and energy harvesting micro-devices.

Bio: Yihui Zhang is an Associate Professor of Engineering Mechanics at Tsinghua University. He received his Ph.D. in engineering mechanics from Tsinghua University in 2011. Then he worked as a Postdoctoral Fellow from 2011 to 2014 and as a Research Assistant Professor from 2014 to 2015, both at Northwestern University. He joined the Department of Engineering Mechanics at Tsinghua University in 2015, and was tenured in 2018. His research interests include mechanically guided 3D assembly, soft composite materials and stretchable electronics. He has published more than 120 peer-reviewed journal papers, including 3 in *Science*, 13 in *Nature sister journals*, 4 in *Science Advances*, 6 in *PNAS*, 10 in *Journal of the Mechanics and Physics of Solids*, 4 in *Advanced Materials* and 6 in *ACS Nano*, as of September 2019. His recent awards include ASME Thomas J.R. Hughes Young Investigator Award (2019), Society of Engineering Science's Young Investigator Medal (2018), ASME Sia Nemat-Nasser Early Career Award (2018), Eshelby Mechanics Award for Young Faculty (2017), ASME Melville Medal (2017), NSFC Excellent Youth Funding (2017), MIT Technology Review's 35 Innovators Under 35 (2016) and Qiu Shi Outstanding Young Scholar Award (2016). He is an associate editor of *Mechanics of Materials* and *Journal of Applied Mechanics*, and serves on the editorial board of several academic journals, such as *Current Opinion in Solid State & Materials Science*, *Proceedings of the Royal Society A*, *SCIENCE CHINA Technological Sciences*, *npj Flexible Electronics*, among others.