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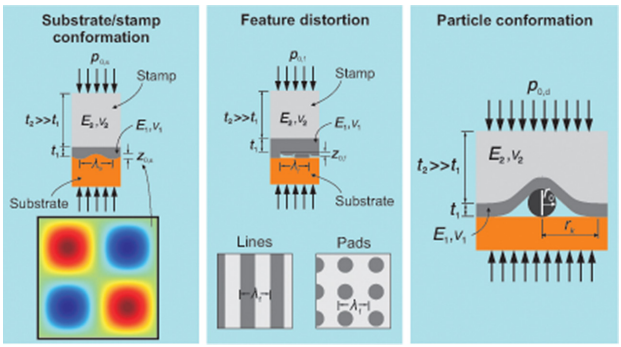
New modeling framework helps tailor designs of micro- and nano-structured stamps

Chris Patrick

New modeling framework allows rapid comparison of designs for micro- and nano-structured stamps used to mechanically transfer patterns onto devices.



Micro- and nano-structured stamps can efficiently transfer patterns onto substrates during the manufacturing of semiconductors and optical devices. Engineers can tailor stamp properties, like elasticity and thickness, to accommodate complex substrate surfaces and errant particles without excessive deformation, but the number of possible combinations of these parameters is nearly endless and an ideal design for a specific application is often difficult to pinpoint.

To make the stamp design process more efficient, Taylor and O'Rorke created a modeling framework that can simulate stamp-substrate contact for two-layered stamps, which have a layer of finite thickness bonded to a thicker layer with varying elasticity. Co-author Hayden Taylor said that this modeling framework makes it possible to quickly compare different stamp designs without experimental trial-and-error.

The authors' framework integrates previous experimental work and uses a Green's function to describe how a stamp surface responds to a localized unit load. Their simulations utilize this approach to describe how the stamps deform in response to the distributed loads that result when patterned stamps come into contact with substrates. The deformed stamp shape is essentially the spatial convolution of the Green's function with the pressure distribution solution. The researchers used their simulations to investigate how stamps conform to different substrate surfaces and trapped dust particles.

One unexpected finding from the authors' simulations could help minimize defects caused by dust particles: The authors expected that a more flexible stamp would be less affected by a particle. However, they found that a stamp with a thin flexible layer bonded to a more rigid layer can better conform to a particle than a totally flexible stamp.

Source: "A computational design framework for two-layered elastic stamps in nanoimprint lithography and microcontact printing," by Hayden Taylor and Richard O'Rorke, *Journal of Applied Physics* (2019). The article can be accessed at https://doi.org/10.1063/1.5081495.

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