Stencil Lithography: Quick, Clean and Cost-Efficient Nanopatterning

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BACKGROUND and BASICS

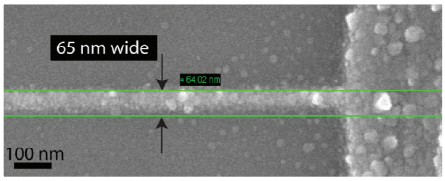
Stencil lithography, a high resolution shadow mask technique, belongs to the class of emerging nanopatterning methods [1]. In contrast to e.g. nanoimprint lithography or micro-contact printing, no photoresist, chemical processing and physical contact between mask and surface is required, which makes vacuum stenciling inherently clean and applicable to fragile, sensitive surfaces.

CONCEPT and SOLUTION

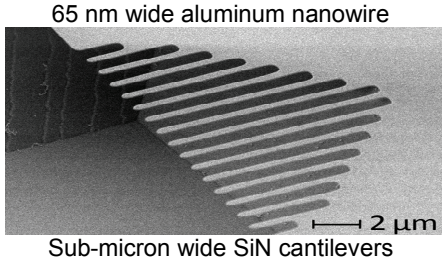
Stencil lithography uses a shadow mask (i.e. stencil membrane with apertures) to block part of a directed material flux. Three steps are involved in the stencil lithography process:

- First, the stencil is aligned and fixed on to a substrate.
- Second, the stencil/substrate combination is placed in a material flux and a controlled amount of material is deposited on and through the stencil.
- The third step consists of the stencil being removed, leaving the locally deposited micro and nanostructures on the target substrate.

The stencil can be reused several times for subsequent stencil lithographic processes [2].



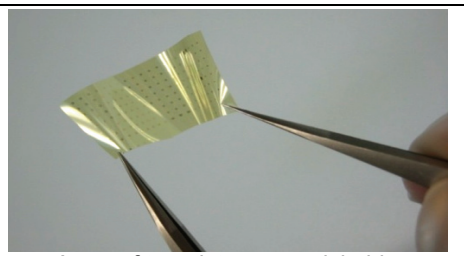
65 nm wide aluminum nanowire

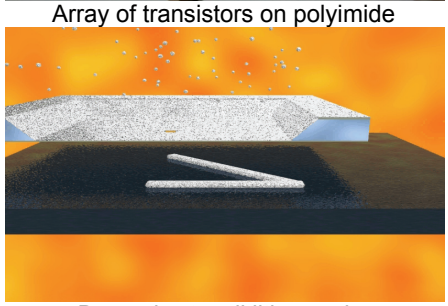


Sub-micron wide SiN cantilevers

STATUS and OUTLOOK

Applications include patterning of sub100nm wide nanowires [3], micro contacts or nano dot arrays. The absence of photoresist, solvent and baking steps allows applying stenciling also to polymer substrates [4] for future plastic electronic applications and/or for cell adhesion experiments [5]. Latest results show that stencil lithography can be also used for dry etching. A stencil covered with an aluminum protection layer is fixed on a substrate. The stencil/substrate combination is exposed to dry etching chemistry, after which the stencil is removed, leaving the transferred pattern in the substrate. Using stencil lithography for dry etching, sub-micron wide nitride cantilevers have been fabricated [6]. A dynamic stencil lithography prototype has been recently developed for step-and-repeat and free-motion patterning [7]. This system allows the characterizationof an atomic flux through small apertures using nanomechanical mass sensor.


Array of transistors on polyimide


Dynamic stencil lithography

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[2] O. Vazquez et al., in Transducers'2007, **2007**.
[3] O. Vazquez-Mena et al., IEEE-NEMS 2008 Proceedings, pp. 786-772, **2008**.
[4] K. Sidler et al., Microelectronic Engineering, 85, pp. 1108-1111, **2008**.
[5] K. Pataky et al. (manuscript in prep).
[6] G.Villanueva et al., Microelectronic Engineering, 85, pp. 1010-1014, **2008**.
[7] V. Savu et al., JVST B, 26, pp. 2054-2058, **2008**.

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