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Designing and Validating Bridges on Stencils

Master/Semester project

(Section: Microengineering – Physics – Materials Science)

Stencil lithography is a resistless micro-fabrication method using a silicon nitride film stencil for pattern deposition or etching.[1] It enables sub-nanometer scale patterns without the need for photoresist or liquid environments. However, challenges include the inability to pattern closed-loop designs due to film detachment, and the risk of stencil curvature or breakage caused by inner stress. Researchers have explored stencil movement during deposition and other approaches to address these issues.

At LMIS1, a new solution was proposed, incorporating auxiliary bridges in stencils. These bridges serve dual purposes: securing the suspended part of the stencil and preventing membrane curvature. By maintaining a specific gap between stencil and substrate, blurring effects during deposition ensure continuous pattern coverage beneath the bridges. Extensive measurements of morphology and electrical properties have validated the effectiveness of the bridge stencil.

The focus of this student project is to optimize the design parameters of bridge stencils. Previous simulations and calculations have revealed interesting phenomena associated with the addition of bridges on the stencil. In this project, students will verify these phenomena in the CMi cleanroom. The tasks will include fabricating bridge stencils with varying parameters, measuring stencil bending, and assessing the profile of deposited patterns through the stencil. These measurements will evaluate the impact of different bridge configurations. The ultimate goal is to develop guidelines for an automated design tool for bridge stencils.

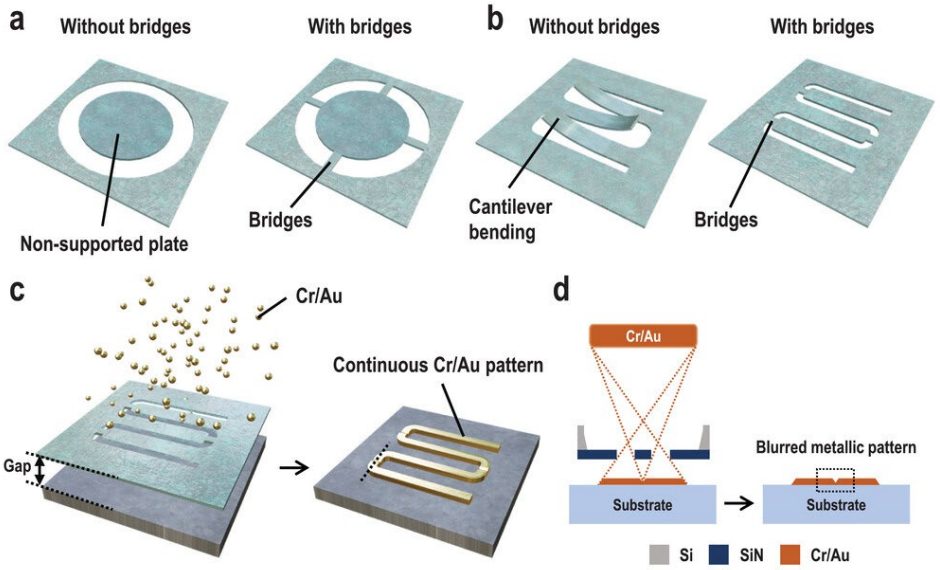

Figure 1 : *The concept of bridge stencils and the blurring effect. a,b) Schematic drawings showing the use of bridges for a) realizing unfeasible geometries on stencils (e.g., close-loop circular apertures), and b) suppressing the bending of cantilevers for meandering apertures. c,d) Schematic drawing showing the beneficial use of the blurring effect.* [2]

Possible tasks:

- Fabrication of bridge stencils and deposition through it
- Measurement of bending of bridge stencil, and profile of deposited patterns
- Verifying the simulation and calculation result, and concluding the concept for designing bridge stencils

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[1] O. Vazquez-Mena et al, vol. 132, pp. 236–254, Jan. 2015.
[2] Y.-C. Sun et al, *Adv. Mater. Technol.*, vol. n/a, no. n/a, p. 2201119.

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