Making large free-standing multi-layer graphene-graphitic membranes

Evgenia Kurganova[1]
A.J.M. Giesbers[2], Sten Vollebregt[3], Arnoud Notenboom[1], David Vles[1], Maxim Nasalevich[1], Peter van Zwol[1]

[1] *ASML, De Run 6501, Veldhoven, The Netherland*
[2] *Philips Innovation Services, High Tech campus 4, Eindhoven, The Netherlands*
[3] *Delft University of Technology, Feldmannweg 17, Delft, The Netherlands*

Evgenia.kurganova@asml.com

Graphene and very thin graphitic membranes have special properties. In the field of lithography, the high absolute transmission around 13. 5 nm, the wavelength of choice of extreme ultraviolet (EUV) lithography, is an attractive property of thin carbon based membranes. Making large size ultrathin membranes is a challenge. As is well known, single layer graphene is a very strong material thanks to the honeycomb lattice and the pi-bonding between the carbon atoms. Therefore, graphene has been proposed being the ultimate material for large free standing membranes.

In reality, however, its high strength of ~100 GPa is limited to defect free mono-crystalline material, which does not exceed areas of the order of a square mm. In practice, we therefore focus within ASML on finite thickness graphitic membranes with thicknesses of a few nanometers. In thin multilayer material, the membrane strength is found to be limited by local stress concentrations due to grain boundaries, considerable surface roughness, and also local holes.

We report on the status of our free standing thin graphitic membranes optimized in collaboration with our industrial and academic partners. Although being able to produce 12 nm thick freestanding membranes of 24x 24 mm^2 size, we found that the mechanical strength did not exceed 360MPa, a strength that needs improvement. In small steps we have reduced the roughness and the number of holes in the graphitic membrane, making the membrane stronger.
In our poster/talk we will highlight our most interesting results and challenges.