Faraday Cage Reactive Ion Etching: Simulation and Experiments

P. Latawiec, Y.-I. Sohn, M. Burek, M. Lončar

School of Engineering and Applied Sciences, Harvard University, 29 Oxford St, Cambridge, MA 02138
platawiec@fas.harvard.edu

Thin film technologies provide electrical, mechanical, or optical isolation between different components of nanofabricated systems. In the cases where high-quality films or substrates are needed, thin film approaches may not exist for certain materials. By using Faraday cages during the etching process, the incident ions may be directed at the substrate at an oblique angle of incidence [1, 2], releasing the structure from the substrate and creating a free-standing etched device. Such a process has seen success in fabricating diamond nanophotonic and nanomechanical resonators[3].

Despite the recent surge in interest, the physics behind the angle etching process has not been fully elaborated. Using simulation and experimental results, we show that the etching angle is dependent on number of Faraday cage parameters. Chief among these is the effect of mesh pitch and size. At larger mesh pitches, simulations show that there is a significant leakage of ions to the inside of the cage, creating a primary ion sheath at the cage boundary and a secondary sheath at the sample. This can create a region where ions incident on the sample are re-deflected downward, thereby lessening the impact of the Faraday cage.

Silicon etched under the SF6/C4F8 etch chemistry with an alumina hard mask is used as a testbed for varying different etch parameters. The experimental investigation is followed by a discussion of the applications of this process for silicon nanophotonics and nanomechanic, along with extensions of the process framework to other material systems.

[1] Lee, J.K., Lee, S.H., Min, J.H., Jang, I.Y., Kim, C.K., Moon, S.H., 2009. *Journal of the Electrochemical Society, 156 (7), D222-D225 CODEN: JESOAN; ISSN:0013-4651. (Electrochemical Society)*

[2] Boyd, G. D.; Coldren, L. A.; Storz, F. G. 1980 *Applied Physics Letters, 36 (7), 583-5 CODEN: APPLAB; ISSN:0003-6951.*

[3] Burek M., de Leon, N., Shields B., Hausmann, B., Chu Y., Quan Q., Zibrov A., Park H., Lukin M., and Lončar M. 2012 *Nano Letters 12* (12), 6084-6089