Investigation of reactive ion etching on diamond using electroplated nickel hardmask for fabricating x-ray diffractive gratings

Kenan Li[1], Yanwei Liu[1], Donald Gardner[1], Anne Sakdinawat[1]

[1]*SLAC National Accelerator Laboratory Menlo Park, CA 94061*
kenan@stanford.edu

Diamond, due to its high thermal conductivity, has emerged as an essential material for x-ray diffractive optics, especially for high power x-ray beams available from free electron lasers. Diamond diffractive optics require high efficiency and wavefront preserving capability, which translates into the need to be able to perform nanofabrication with high aspect ratios, low roughness and good uniformity. The physical hardness and chemical stability of diamond however, make nanofabrication challenging.

In this paper, electroplated nickel is used as a hardmask to etch diamond with oxygen-based reactive ion etching. The etch rate variations, effect of RF power pulsing, etch front roughness, etch depth dependency on linewidth, effect of RF power morphing, sidewall flatness and etch depth uniformity, effect of adding fluorine, and hardmask selectivity and redeposition have been investigated. Based on the experimental results, diamond gratings either with a high aspect ratio of up to 25 or with a high quality of etching profile and depth uniformity were achieved.

As a result, we propose two recipes for etching diamond gratings: (1) using RF pulses with gradually increasing power to achieve deep depth, and (2) using RF power only (without ICP) for slow and directional etch, to achieve low etch-front roughness, at sidewall and uniform etch depth.

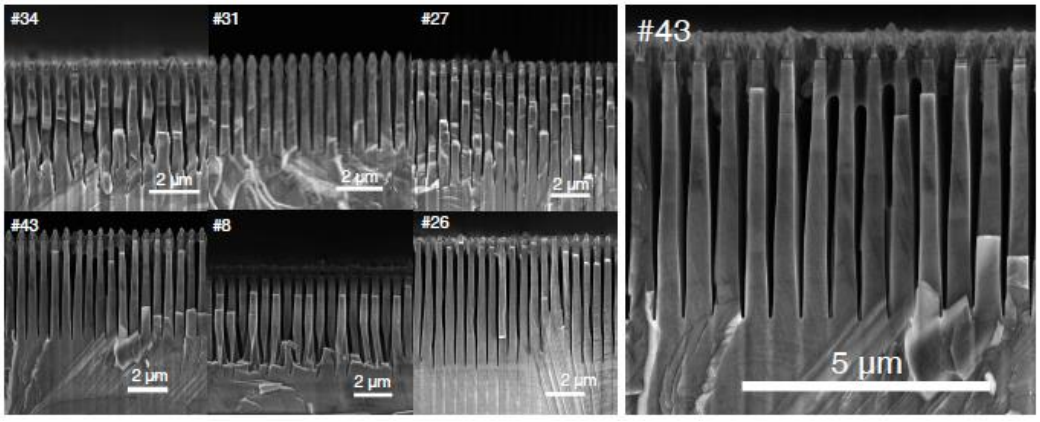

Figure 1 Cross sectional SEM images from six samples with different RIE parameters showing different etch profiles.