Application of Highly Charged Ar Ion Beams to Ion Beam Lithography

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Abstract:

The ion-beam based lithography is one of the useful tools to fabricate nanostructures. In order to expand the applicability of this technique, we introduced highly charged ion beams to this technique. It is expected that the very high activity of highly charged ions leads us to more efficient and unique fabrication.

An Ar beam at 90 keV was irradiated onto spin-on-glass (SOG) applied on a Si substrate through a Cu stencil mask. The Ar ions were prepared by a 10-GHz NANOGAN, which is an ECR ion source developed by PANTECHNIK, and the charge states of Ar ions, 1+ and 9+, were selected by use of a dipole magnet. The dose was monitored during the beam irradiation and the total dose was varied stepwise over the ranges 100 – 500 npC/cm^2. The irradiated SOG was etched by a solution of HF for one minute. The step structure of SOG formed by the etching was observed by use of the alpha-step IQ developed by KLA Tencor Corporation.

The etching pattern was transferred to SOG with an Ar^{9+} beam as well as with an Ar^{1+} beam. The etching depth of SOG increases with the dose of Ar^{9+} ions linearly. It is found that the etching depth of SOG for Ar^{9+} irradiation was about three times deeper than that for Ar^{1+} irradiation. The present results suggest that the very high activity of highly charged ions enhances the etching rate of SOG.