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Fabrication of single- and multi-directional slanted profiles of Si using plasma etching

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Etch profiles with slanted structures are basic units for the formation of three-dimensional nanostructures. These three-dimensional nanostructures having high aspect-ratio slanted profiles can be applied not only to microelectronics but also to light emitting diodes, dry adhesives, photonic crystals, grating couplers, and so on. To obtain three-dimensional nanostructures with slanted patterns, precise control over the angle and aspect ratio of the slanted structures is of primary importance.
Plasma etching has been widely used to fabricate high aspect ratio microstructures due to its anisotropic etching characteristics. In a conventional etching process, a sheath is formed along the surface of the substrate. Therefore, the direction of ions incident on the substrate is vertical to the surface of the substrate irrespective of the angle of the substrate. Accordingly, the conventional plasma etching is not adequate for the fabrication of three-dimensional nanostructures with slanted etch profiles.
In this study, a novel plasma etching technique was demonstrated to obtain single- and multi-directional slanted etch profiles of Si. A Faraday cage system was used to control the angle of ions incident on the substrate. Etching was performed by a cyclic process consisting of alternating etching and deposition steps using SF_6 and C_4F_8 plasmas, respectively. Single-, double-, and quadruple-directional slanted etch profiles were uniformly fabricated under practical plasma processing conditions.

Keywords
Slanted structures
Directional etching
Faraday cage
Ion-incident angle