

Multi-directional plasma etching using a Faraday Cage

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A method to obtain a multi-directional etch profile was investigated using a Faraday cage which was located in a transformer-coupled plasma etcher. A silicon substrate with a 560 nm thick SiO₂ mask was etched in Bosch process, which consisted of sequentially alternating etching and deposition steps, using SF₆ and C₄F₈ plasmas. A mask pattern with a critical dimension of 1 μm was obtained in a reactive ion etching process, which was followed by deep ultraviolet lithography. The Faraday cage consisted of copper sidewalls and a top grid plane, which produced an internal space that was free of an electric field. Therefore, ions, which were accelerated in a sheath formed on the grid plane, maintained their initial direction that was normal to the grid plane. Two types of Faraday cages were used for this experiment. Type 1 had a horizontal grid plane and a slanted substrate holder. Type 2 had two slanted grid planes and a horizontal substrate holder. The etching direction was determined by an angle between the surface, which was normal to the grid plane, and the substrate surface. Based on these techniques, a silicon substrate could be etched in multi-directions.