NASA TECH BRIEF
Langley Research Center

Sputtered Gold Mask for Deep Chemical Etching of Silicon

A method has been developed at Langley Research Center for etching deeply an accurately positioned pattern (e.g., an array of circular holes) in a silicon wafer, using an isotropic etch. A sputtered gold coating, formed into a mask pattern using photolithographic techniques, has the necessary properties to allow deep chemical etching of the silicon. This sputtered mask resists chemical attack from the acid and has the adherence to withstand prolonged submergence in the etch solution without lifting from the silicon surface.

The silicon surface must first be cleaned to obtain good adherence of the gold coating. Each silicon wafer is initially soaked in a hot mixture of concentrated sulfuric and nitric acids (in a ratio of 2:1) for 10 minutes, followed by a 5-minute rinse in deionized distilled water. The silicon is then sputter etched to complete the cleaning procedure.

Without breaking vacuum, a coating of gold (approximately 400 nm thick) is sputtered onto the silicon surface. Using standard photolithographic techniques, the surface is coated with photoresist except on the regions where the gold is to be removed. Then, using the photoresist as a mask, the wafer is sputter etched to remove the gold from the regions to be chemically etched. The sputter etching is accomplished at a sufficiently low power to keep the photoresist from decomposing due to heating effects.

Upon completion of mask fabrication, the wafer is waxed to a sapphire disk to prevent etching of the unmasked face. The wafer is then placed in the etch solution (for this study, a mixture of concentrated nitric, acetic, and hydrofluoric acids in the ratio of 30:5:4 was used) and is agitated to keep bubbles from forming on the surface.

Using this method, an array of circular holes (0.508 mm in diameter) for pressure sensor diaphragms was etched in both {111} and {110} silicon. It was found that hole depths of 250 μm could easily be etched within 2.5 hours. The depths of these holes were uniform within ± 5 μm. Even under prolonged etch conditions with significant undercutting, the gold mask maintained excellent adhesion to the silicon surface and imperviousness to the acid.

Note:

No further documentation is available. Specific questions, however, may be directed to:

Technology Utilization Officer
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Patent status:

NASA has decided not to apply for a patent.

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Categories: 08 (Fabrication Technology)
04 (Materials)
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