Nanometer Scale High-Aspect-Ratio Trench Etching at Controllable Angles

Tech ID: 23139 / UC Case 2012-333-0

BACKGROUND

As feature dimensions in semiconductor devices decrease, it becomes increasingly more important to precisely control dopants at the nanoscale level. One method to achieve such precision with homogenous implants is to use high-aspect-ratio structures in resist to serve as implantation masks. The high aspect ratio of these masks reduces lateral ion straggle and helps keep the implanted profiles sharp and well defined. For gradient doping, thermal diffusion is typically used to grade the profile which in practice is very difficult to precisely control at the nanoscale.

TECHNOLOGY DESCRIPTION

University researchers have developed a novel masking approach to achieve nanoscale gradient doping by fabricating a three dimensional mask using a multilayer approach based on electron beam lithography and ballistic reactive ion etching (RIE) at angles. In the invention, low-pressure RIE is used to pattern nanometer scale angled sidewalls and three dimensional structures in photoresist. At low pressure, the plasma has a large dark space region where the etchant ions have very large highly directional mean free paths. Mounting the sample entirely within this dark space allows for etching at angles relative to the cathode with minimal undercutting, resulting in high-aspect ratio nanometer scale angled features. The method can be applied to wafer-scale fabrication and enables production of three-dimensional mask profiles which can be used as masks for ion implantation, MEMS devices, and patterning of materials that may only be sputter etched (e.g., complex oxides like high-temperature superconductors or manganites).

RELATED MATERIALS

- Related Material: Nanometer scale high-aspect-ratio trench etching at controllable angles using ballistic reactive ion etching J. Vac. Sci. Technol. B 31, 010604 (2013); - 01/07/2013

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	9,653,309	05/16/2017	2012-333

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OTHER INFORMATION

KEYWORDS

ballistic transport, nanopatterning, photoresists, sputter etching, nanoscale gradient doping

CATEGORIZED AS

- **Nanotechnology**
  - Materials
- **Semiconductors**
  - Processing and Production

RELATED CASES

2012-333-0