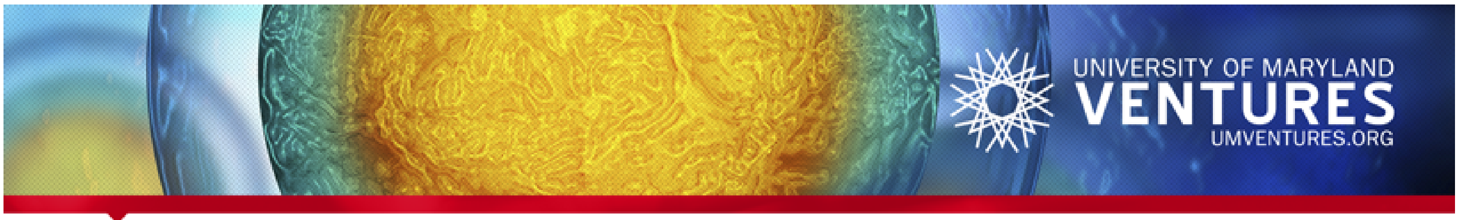


TECHNOLOGY

# Sub-Debye Length Patterned Shutter for Nanoscale Plasma Processing of Materials

## OVERVIEW

Plasma processes for micro-machining, surface modifications, cleaning, sputter coating and many other operations are widely used in the fabrication of microelectronics. The ionized gas in a plasma generates a high concentration of reactive species at 50-100 C and provides a means of cleaning, etching and depositing materials at much lower temperature than is possible by thermally driven reactions alone. A plasma may be considered as an ionized gas consisting of a "chemical soup" of many types of species, such as positive and negative ions, electrons, neutrals, atoms, molecules, clusters, etc. In laboratories, plasmas can be easily generated by striking a high voltage (normally larger than 1 kV) electrical discharge through a low-pressure gas system. This may be achieved using a DC, AC or more usually, high frequency AC operating in the kHz-MHz (radio frequency, RF) or GHz (microwave) regimes.

Nanoscale processing of thin films and substrates by exposure to electrically charged plasmas is a desirable technology for surface modification and other changes of substrates. For plasma processing of nanoscale-sized features, such as thickness, depth and lateral dimensions, the control of the interaction time between the plasma and the work piece is of great importance. Typical etching or deposition rates using plasmas range from a fraction of nm/s to many nm/s. Because of the nanoscale thickness of the material layers that need to be added, modified or removed, the plasma/substrate interaction time has to be short. Simultaneously, a fully established plasma needs to interact with the work piece, rather than a plasma that is still evolving as a function of time, e.g., during the initial transient. This is especially important for chemical reactive discharges.

Inventors at the University of Maryland have developed a system to generate a just in-in-time full plasma for non-scale operations. The plasma processing system includes a source of plasma, a substrate and a shutter positioned in close proximity to the substrate. The substrate/shutter relative disposition is changed for precise control of substrate/plasma interaction. This way, the substrate interacts only with a fully established, stable plasma for short times required for nanoscale processing of materials. The shutter includes an opening of a predetermined width and preferably is patterned to form an array of slits with dimensions that are smaller than the Debye screening length. This enables control of the substrate/plasma interaction time while avoiding the ion bombardment of the substrate in an undesirable fashion. The relative disposition between the shutter and the substrate can be made either by moving the shutter or by moving the substrate.

See U.S. published patent application No. 20050051517. Additional patent applications are pending.

For licensing information contact the University of Maryland, College Park, Office of Technology Commercialization 301 405-3947 or by e-mail otc@umd.edu.

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## Additional Information

### INSTITUTION

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### PATENT STATUS

Patent(s) pending

### LICENSE STATUS

Contact OTC for licensing information

### CATEGORIES

- Nanotechnology + Nanoparticles + Nanomaterials

### EXTERNAL RESOURCES

- US Patent 7,470,329

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