Electron Beam Induced Deposition of Nanostructures

Mode of FEBID with the use of electro-spray-drive liquid jets with new capabilities in the fabrication of topologically-complex 3D nano-structures

A Georgia Tech inventor has developed an innovative mode of FEBID with the use of electro-spray-drive liquid jets with new capabilities in the fabrication of topologically-complex 3D nano-structures, including growth rates for amorphous carbon deposits 3-4 orders of magnitude faster than rates reported from gas-phase deposition. Similarly, the new approach provides faster growth rates of formation of unique high-resolution 3D topologies, such as nano-scale bridges, and simultaneously vertical and side-growing/merging nano-structures, by using precisely controlled formation of a liquid film. The liquid films are produced inside of the vacuum environment of a scanning electron microscopy chamber with a liquid-phase precursor through the use of electro-spray. The liquid precursor is directly delivered from a nano-electro-spray tip onto the substrate, and the extent of the liquid film and its thickness are controlled with adjustment of electro-spray bias and spray capillary tip to substrate separation distance. As a result, sub-micrometer thickness liquid films are successfully established using this method.

Summary Bullets

- Unique nano-fabrication process that allows direct-write of complex 3D nano-structures (e.g. cavities and overhangs)
- Fabrication process compatible with variety of materials on any substrates (planar and non-planar)
- Provides growth rate of amorphous carbon nano-structures 3 times greater than that of standard gas-phase FEBID

Solution Advantages

- Unique nano-fabrication process that allows direct-write of complex 3D nano-structures (e.g. cavities and overhangs)
- Fabrication process compatible with variety of materials on any substrates (planar and non-planar)
- Provides growth rate of amorphous carbon nano-structures 3 times greater than that of standard gas-phase FEBID

Potential Commercial Applications

- Manufacturing processes of 3D nano-structures
- Emerging electronics
- Memory
- Lab-on-chip microelectronic chips/systems
- Sensing applications

Background and More Information

Focused electron beam induced deposition (FEBID) is an emerging additive manufacturing method for direct writing of three-dimensional nano-structure from a variety of materials. It brings the functionality, utility, and flexibility of 3D printing to nano-scale. In the process, material is grown atom-by-atom or via a reaction of an irradiating electron beam with precursor material. FEBID has been increasingly used as a nano-manufacturing tool for many applications, ranging from IC mask repair, to electrical interconnect fabrication, and to rapid prototyping of opto-electro-mechanical devices. Discovering new methods for the fast growth of micro-structures with 3D topological complexity and control of phase composition is an essential step for broadening the application base of FEBID as a versatile nano-manufacturing tool.

Inventors

- Dr. Andrei Fedorov
  Professor and Rae S. and Frank H. Neely Chair - Georgia Tech School of Mechanical Engineering

IP Status

: US20180178227A1

Publications

, -

Images

Visit the Technology here:
Electron Beam Induced Deposition of Nanostructures