Carbon Nanotube Cold Cathodes

Carbon nanotube based ion thrusters with improved electron emission sources

Georgia Tech researchers have developed carbon nanotube based ion thrusters with improved electron emission sources. In particular, the researchers have developed a cathode for an ion thruster that has a conductive base layer and an insulating layer that is disposed on the conductive base layer and has a plurality of apertures therein. The conductive base layer can be formed from a metal, semi-metal, or semiconductor. In some cases, the conductive base layer is formed from an n-type semiconductor. The cathode can further include a conductive gate layer that is disposed on the insulating layer and has a plurality of apertures therein. The plurality of apertures of the insulating layer and the plurality of apertures of the conductive gate layer can be substantially coaxial. At least a portion of a side wall and/or a bottom surface of a distal end of each aperture of the plurality of apertures of the conductive gate layer can be exposed to a surface of the conductive base layer. Each aperture of the plurality of apertures of the insulating layer can be tapered such that the aperture is larger at an end distal from the conductive base layer than at an end proximal to the conductive base layer.

Summary Bullets

- More efficient electric propulsion
- Reduced power and mass expenditures
- Does not require gas flow to emit electrons

Solution Advantages

- More efficient electric propulsion
- Reduced power and mass expenditures
- Does not require gas flow to emit electrons
- Does not require a heater element- less load on spacecraft/satellite
- Results in higher propulsion efficiency

Potential Commercial Applications

- Low-power engines
- Hall thrusters, electrostatic ion thrusters, field emission electric propulsion (FEEP) thrusters, and colloid thrusters
- Spacecrafts and satellites

Background and More Information

Ion thrusters use an electron source to neutralize the ionized reaction mass. Most ion thrusters employ thermionic hollow cathodes, which require a gas flow in order to emit electrons. This propellant does not contribute to the thrust of the engine, yet still must be carried by the spacecraft or satellite. In addition, hollow cathodes can require a heater element, which is an additional load on the spacecraft or satellite power system. Since most low-power electric propulsion engines have limited power capacities, any expenditure in power (e.g., additional propellant needed for the hollow cathode, heat for the hollow cathode, or the like) that does not directly generate thrust is a source of inefficiency. Thus, there is a need for improved electron sources for neutralizing exhaust plumes in low-power electric propulsion devices. It would be particularly advantageous if the improvements reduced or eliminated power and mass expenditures that do not directly generate thrust. Such improved electron sources would provide more efficient electric propulsion devices.

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Publications

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