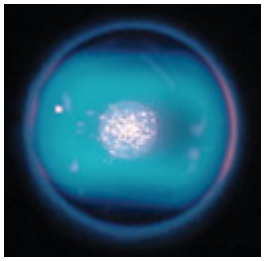

WINNER

2004 R&D 100 Awards Winner

Plasma-Torch Production of Spherical Boron Nitride Particles

Particles of heat-dissipation filler can be added to the resin packaging around an integrated circuit to improve thermal management. Crystalline boron nitride, with the highest thermal conductivity of any ceramic, would be the most effective filler material except that it naturally forms as irregular platelets. Only spheres have the right rheological (material flow) characteristics for semiconductor packaging tools and techniques. We have succeeded in melting crystalline (hexagonal) boron nitride by injecting the natural platelets into a hot (>3,500 kelvin) plasma, whose nitrogen-atom-rich environment stabilizes boron nitride, allowing it to be heated to its melting point. The particles melt, form spheres, and retain that shape when cooled. Ours is the first process to produce crystalline boron nitride spheres.

Applications

Our plasma-torch method produces a variety of materials:

- Spherical crystalline boron nitride for integrated-circuit packages
- Oxide spheres for integrated-circuit packages
- Carbon nanotube threads with the highest strength-to-weight ratio for ropes and other structures
- Photocatalysts for hydrogen generation and water purification
- Supported metal catalysts for crude-oil refinement, catalytic converters, and polymers
- Metallic and carbon-coated metallic nanoparticles as fuel components
- Oxide nanoparticles, possibly for next-generation armor