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11859

Patent(s) Issued

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**Awards Won:**

R&D 100 Award - 2006

U.S. DEPARTMENT OF ENERGY

Available Technologies

# Supercritical CO2 for Coating Applications

## SUMMARY

Presented here is the application of nanometer thick polymer films onto metal and semiconducting substrates. In the first step, nanometer sized polymer particles are generated by a process of homogeneous nucleation during the rapid expansion of supercritical fluid solutions. These gas-phase particles are then charged as they are being formed by application of a high voltage to the expansion nozzle. In this way, the charged nanoparticles can be collected on a solid surface, forming uniform coatings with thicknesses from tens of nanometers to several micrometers thick. This represents a 'green' process for film deposition. A further unique aspect of this process is that the small charged nanoparticles can be deposited to electrically conducting microscopic regions with a spatial resolution better than 50 nm.

The rapid expansion of supercritical fluid solutions through a small orifice (referred to as the RESS process) produces an abrupt decrease in dissolving capacity of the solvent as it is transferred from a supercritical fluid state to a very low density gas phase after the expansion. This abrupt transition in solvent characteristics results in the nucleation and growth of nanometer-sized particles from any low vapor pressure solute species that are dissolved in the solution prior to expansion. Because the solvent is transformed into a gas phase during the RESS expansion, RESS products are generated 'dry,' without any residual liquids or solvents.

A difficulty with the RESS process for the last two decades has been that particles in the range from 10 to 500 nm are difficult or impossible to deposit on a surface since their extremely low mass causes them to remain entrained in the expansion gas. The work presented overcomes this challenge by charging the particles with an electric field applied to the tip of the expansion nozzle.

The resulting films are superior to those produced by conventional deposition techniques.

Details have been published: "Thin fluoropolymer films and nanoparticle coatings from the rapid expansion of supercritical carbon dioxide solutions with electrostatic collection," John L. Fulton, et al., Polymer, 2003, 44, 3627.

## Patents & Intellectual Property

- Patent #: 6,756,084
- Patent #: 6,780,475

## Technology Portfolio(s)

- Supercritical Fluid Processing

## Potential Industry Applications

- Chemicals

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