



## Manufacturing & Prototyping

### Thermal Spray Formation of Polymer Coatings

*John Glenn Research Center, Cleveland, Ohio*

This innovation forms a sprayable polymer film using powdered precursor materials and an in-process heating method. This device directly applies a powdered polymer onto a substrate to form an adherent, mechanically-sound, and thickness-regulated film. The process can be used to lay down both fully dense and porous, e.g., foam, coatings. This system is field-deployable and includes power distribution, heater controls, polymer constituent material

bins, flow controls, material transportation functions, and a thermal spray apparatus.

The only thing required for operation in the field is a power source. Because this method does not require solvents, it does not release the toxic, volatile organic compounds of previous methods. Also, the sprayed polymer material is not degraded because this method does not use hot combustion gas or hot plasma gas. This keeps

the polymer from becoming rough, porous, or poorly bonded.

*This work was done by Scott Cogull, Stephen L. Galbraith, Darren L. Tuss, Milan Ivosevic, and Lawrence Farrar of Resodyn Corporation for Glenn Research Center.*

*Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4-8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18246-1.*

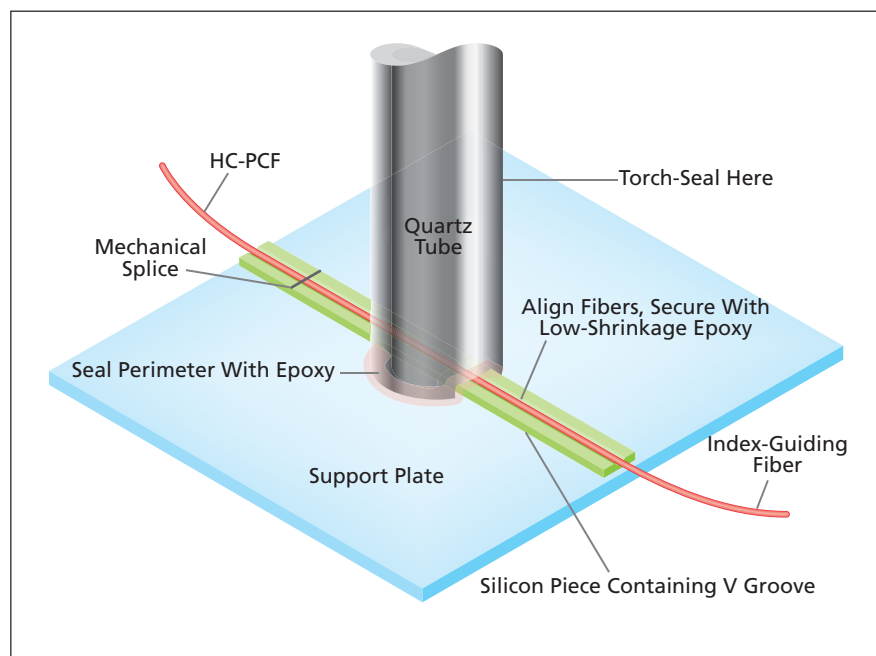
### Improved Gas Filling and Sealing of an HC-PCF

**Compact hermetic joint is formed to seal connectorized all-fiber gas reference cell.**

*NASA's Jet Propulsion Laboratory, Pasadena, California*

An improved packaging approach has been devised for filling a hollow-core photonic-crystal fiber (HC-PCF) with a gas, sealing the HC-PCF to retain the gas, and providing for optical connections and, optionally, a plumbing fitting for changing or augmenting the gas filling. Gas-filled HC-PCFs can be many meters long and have been found to be attractive as relatively compact, lightweight, rugged alternatives to conventional gas-filled glass cells for use as molecular-resonance frequency references for stabilization of lasers in some optical-metrology, lidar, optical-communication, and other advanced applications. Prior approaches to gas filling and sealing of HC-PCFs have involved, variously, omission of any attempt to connectorize the PCF, connectorization inside a vacuum chamber (an awkward and expensive process), or temporary exposure of one end of an HC-PCF to the atmosphere, potentially resulting in contamination of the gas filling. Prior approaches have also involved, variously, fusion splicing of HC-PCFs with other optical fibers or other termination techniques that give rise to Fresnel reflections of about 4 percent, which results in output intensity noise.

In the improved approach (see figure), at first, one end of an HC-PCF is



**A Quartz Tube Is Attached and Sealed With Epoxy** to an assembly that includes a mechanical splice between an HC-PCF and a solid-core optical fiber. The tube is used for evacuation and gas filling of the HC-PCF.

mechanically spliced to one end of an index-guiding optical fiber, the end face of which has been cleaved at an angle to suppress Fresnel reflections. The fibers are placed in a V-cross-section groove in a piece of silicon with a gap of 30 to 100

$\mu\text{m}$  between their end faces. The fibers are fixed in place in the groove by use of a low-shrinkage epoxy. The gap between the end faces of the fibers is small enough to ensure adequate optical coupling, yet it accommodates flow of gas

into and out of the HC-PCF.

The V-groove silicon piece that supports the mechanical splice rests on a support plate. One end of a quartz tube is prepared by contouring it to fit over the V-groove silicon piece and support plate. This end of the tube is put in place to cover the splice region, and an epoxy is used to seal the tube to the V-groove silicon piece, the optical fibers, and the support plate.

The other end of the quartz tube is inserted into a plumbing fitting of a vacuum chamber, which is equipped with valves and connected to a vacuum pump for removal of air from the interior of the HC-PCF, and to a gas cylinder and pressure gauge for filling the interior of the HC-PCF with the desired gas. In a typical application, once the HC-PCF has been filled with the gas, the quartz tube is torch-sealed, forming a relatively

compact hermetic junction. Alternatively, if the plumbing fitting includes a valve, it can be left in place to enable re-evacuation and/or refilling of the HC-PCF without the necessity of breaking and remaking the splice.

*This work was done by Ilya Poberezhskiy, Patrick Meras, Daniel Chang, and Gary Spiers of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-45193*