Symposium SM2 – Advanced Multifunctional Fibers and Textiles

High Pressure Chemical Vapor Deposition of Optoelectronic Fiber Materials

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High Pressure Chemical Vapor Deposition (HPCVD) allows for the deposition of structured elemental and compound semiconductors into the empty pores of microstructured optical fibers.[1,2] It can fill these pores completely void-free with unary semiconductors over long lengths to form near atomically smooth (~0.1 nm RMS surface roughness), very geometrically perfect (round, uniform cross sectional diameter) fiber cores of hydrogenated amorphous, amorphous, or crystalline silicon or germanium.

Laser heating elemental semiconductor fiber cores[3] has allowed for single crystal small core (1-2 μm) silicon and germanium[4] optical fibers with optical losses as low as 0.5 dB/cm. Small cores are important for single mode or near single mode optical guidance. These elemental semiconductor fiber cores can serve as the building blocks for optoelectronic devices, such as meter-long *pin* junctions[5] and GHz bandwidth in-fiber detectors.[6] Seamless coupling of semiconductor optoelectronic and photonic devices with existing fiber infrastructure thus becomes possible, facilitating all-fiber technological approaches. There has been much interest in the possibility of woven solar fabrics incorporating efficient silicon junctions.

HPCVD was later extended to demonstrate the first small core crystalline compound semiconductor ZnSe optical fibers, which are capable of guiding near/mid infrared optical powers 2 to 3 orders of magnitude higher than conventional chalcogenide glass fibers. These ZnSe fibers can be doped with chromium to allow for continuous wave tunable infrared fiber lasers. Synthesis of carbon nanothreads inside optical fiber pores represents a promising direction for realizing fibers of unprecedented mechanical strength to weight ratio and novel properties associated with mixed sp^2/sp^3 carbon hybridization.[7]

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