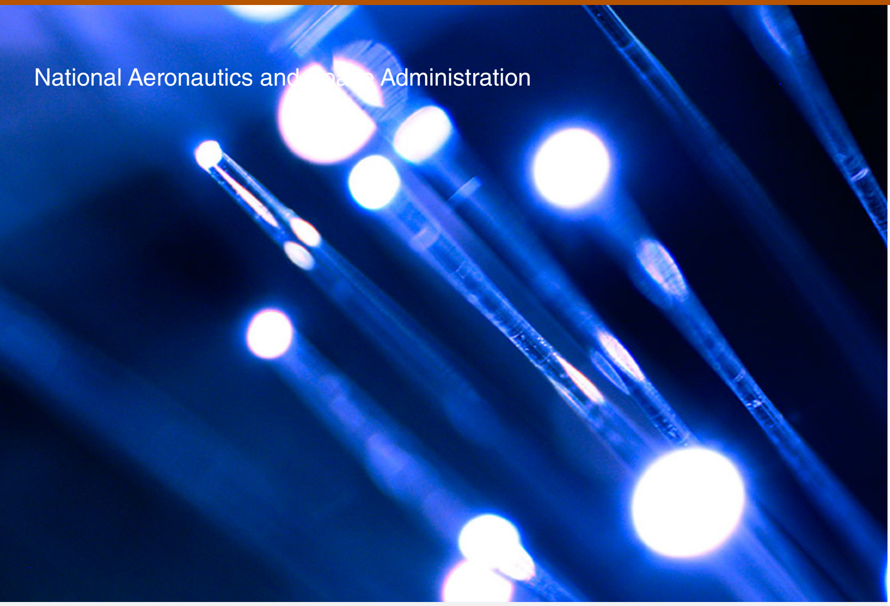

Optics

Crystal-free Formation of Non-Oxide Optical Fiber

Utilizing magnetic fields to suppress crystallization in non-oxide fiber preforms

Researchers at NASA Marshall Space Flight Center have devised a method for the creation of crystal-free non-oxide optical fiber preforms. Non-oxide fiber optics are extensively used in infrared transmitting applications such as communication systems, chemical sensors, and laser fiber guides for cutting, welding and medical surgery. However, some of these glasses are very susceptible to crystallization. Even small crystals can lead to light scatter and a high attenuation coefficient, limiting their usefulness. NASA has developed a new method of non-oxide fiber formation that uses axial magnetic fields to suppress crystallization. The resulting non-oxide fibers are crystal free and have lower signal attenuation rates than silica based optical fibers.

BENEFITS

- Reduced Signal Attenuation
- Radiation Resistant
- Increased Fiber Strength
- Infrared Signal Transmission

technology solution

THE TECHNOLOGY

Signal propagation through traditional silica-based optical fibers is limited to visible and near-infrared wavelengths. In contrast, non-oxide glasses such as chalcogenide and heavy metal fluoride glasses (e.g. "ZBLAN") are highly transparent from near ultraviolet to mid-infrared wavelengths and have lower theoretical signal attenuation rates, resulting in the ability to transmit wideband signals over significant distances with minimal losses. Theoretical estimates for signal attenuation losses for non-oxide fibers yield values of approximately 0.001 dB/km for a transmitted wavelength of 2.55 micrometers. The theoretical loss for the state of the art fused silica is two orders of magnitude higher at 0.12 dB/km at 1.55 micrometers. However, there are a number of crystals and defects which can serve as scattering centers in non-oxide glass preforms and fibers. These include ZrF_4, LaF_3, AlF_3, ZrO_2, platinum particles from crucible reactions, carbon from organic impurities and crucible reactions and bubbles due to contraction, cavitation and gas precipitation. Using this patented preform formation technology, the fibers heated in the 0.1-T magnetic field did not show evidence of crystallization under optical microscopy or Scanning Electron Microscopy (SEM).

As seen in Figure 1 and Figure 2, an axial magnetic field has the effect of suppressing crystallization in ZBLAN. The experiments indicate that the combination of a vertical magnetic field and a rapid cool down from the crystallite melting temperature will ensure that no crystals are present in the preform after processing.

FIGURE 1 – an SEM image of a ZBLAN fiber processed in unit gravity. Clearly visible crystals were formed in the bulk of the fiber. These crystals significantly increase signal attenuation.

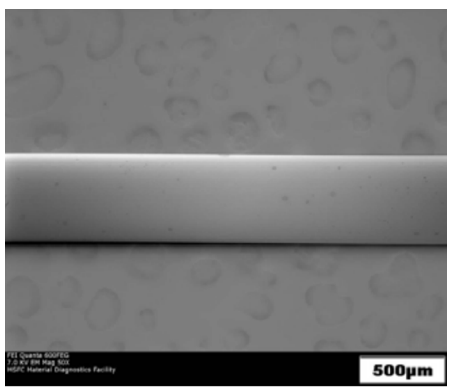

FIGURE 2 – an SEM image of a ZBLAN fiber processed with a magnetic vector anti-parallel to the gravity vector. Processing in the presence of a magnetic field eliminated crystal formation and would decrease signal attenuation.

APPLICATIONS

The technology has several potential applications:

Medicine – surgical and cutting lasers

Nuclear – radiation resistant optical fibers

Communication – low loss, infrared communication fiber

Sensors – remote optical sensing in harsh environments

Optics – optical amplifiers, Bragg reflectors, and laser transmitters, optical waveguides

PUBLICATIONS

U.S. Patent 7,848,606 B1

More Information

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