UNDERSTANDING THE ROLE OF GRAVITY IN THE DEVITRIFICATION SUPPRESSION OF ZBLAN GLASS

Anthony Torres, Ph.D.
Assistant Professor
Department of Engineering Technology
Texas State University

ABSTRACT

Fluorozirconate glasses, such as ZBLAN (ZrF_4-BaF_2-LaF_3-AlF_3-NaF), have the potential for optical transmission from 0.3 μm in the UV to 7 μm in the IR region. However, crystallites formed during the fiber drawing process prevent this glass from achieving its low loss-capability. Other researchers have shown that microgravity processing leads to suppressed crystal growth in ZBLAN glass, which can lead to lower transmission loss in the desired mid-IR range. However, the mechanism governing crystal growth suppression has not been thoroughly investigated. In the present research multiple ZBLAN samples were subjected to a heating and quenching test apparatus on a parabolic aircraft under controlled μ-g and hyper-g environments and compared with 1-g ground tests. Optical microscopy (transmission and polarized) along with SEM examination elucidates crystal growth in ZBLAN is suppressed when processed in a microgravity environment. Hence crystallization occurs at a higher temperature in μ-g and the working temperature range at which the fiber can be manufactured has been expanded.

We postulate that the fundamental process of nano-scale mass transfer (lack of buoyancy driven convection) in the viscous glass is the mechanism responsible for crystal growth suppression in microgravity. Suppressing molecular mobility within the semi-molten glass starves nucleating crystallites and prevents any further growth. A COMSOL Multi-Physics model was developed to show the velocity contours due to convection processes in a 1-g, μ-g, and hyper-g environment. Analytical models show that while suppressing convection is relevant at fiber drawing temperatures (360°C), mass transfer due to diffusion dominates at higher temperatures leading to crystal growth at temperatures ≥400°C.

HOW TO BE SUCCESSFUL IN YOUR CAREER

Advice From A Young Faculty Member

Anthony Torres, Ph.D.
Assistant Professor
Department of Engineering Technology
Texas State University

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Approximately 2.3 million search results come up when Google-ing, “How to be successful in your career”. However, there is limited information from a young faculty member to aspiring doctoral candidates. Come hear how I, a newly minted Ph.D. and Assistant Professor, profited from my education and successfully landed a faculty position. I’ll go over how to identify an advisor, a research topic, an internship or collaborative research project, as well as the process of applying and interviewing for an academic position. I’ll share my experiences with industry (Air Force Research Laboratory/NASA) and ways you can get involved with research laboratories/institutions. Lastly, I’ll cover what to expect once you land an academic position.

Dr. Anthony Torres Bio:

Dr. Torres, a native of New Mexico, joined the Department of Engineering Technology (Concrete Industry Management program) in August 2013 and is presently teaching Understanding the Concrete Construction System. Prior to joining Texas State University, Dr. Torres worked as a Materials Engineer for the Air Force Research Laboratory where his doctoral research focused on the microstructural characterization of mid-IR fiber optics under a reduced gravity environment. Dr. Torres’ expertise led him to be the primary investigator of materials processing on board NASA’s zero-gravity aircraft. Dr. Torres also has experience working as a structural design engineer as well as a welding/material fabricator.

Dr. Torres received both of his graduate degrees, Ph.D. and M.S., in Civil Engineering (Structural), from the University of New Mexico. His B.S. degree, also in Civil Engineering, was obtained from New Mexico State University.

Dr. Torres’ research background primarily focused on the science and advancement of materials. Past research focused on the design and alteration of woven carbon fiber composites. This research is applicable to the vast world of composite materials, in particular, structural areas of mixed-mode stress concentrations. His current research areas involve two separate ventures. One area focuses on the characterization and analysis of cementitious materials, while the other centers on using zero-gravity as a parameter in materials processing for superior material properties.