Failure of an Additive Manufactured Heat Exchanger Due to Environmentally Assisted Nitridization

Abstract: Nitriding of steel and other metals is a beneficial surface treatment that diffuses nitrogen into the material, resulting in a hard, wear-resistant surface. Inadvertent nitriding, or nitridization, is failure mechanism that can occur in metals in a nitrogen-rich environment at elevated temperatures. The growth of continuous hard nitride networks sharply reduces fracture toughness, leading to premature cracking under mechanical or thermal loads and a decrease in fatigue resistance. This talk will provide a tutorial on the beneficial aspects of nitriding, then will present a case study of failure by nitridization of an additively manufactured nickel-base alloy heat exchanger used for space applications. The failure analysis consisted of computed tomography (CT), optical microscopy/metallography, and scanning electron microscopy (SEM) in conjunction with energy dispersive spectroscopy (EDS).

Biography: Thomas Ackerson is a materials testing executive with over 37 years of experience in metallurgical and non-metallic testing and characterization, failure analysis, forensic investigation, litigation support/expert witness, optical and electron microscopy, and corrosion testing/prevention. His education includes a B.S. in Materials Science and Engineering from North Carolina State University, an MBA from Averett University, and various continuing education short courses. Tom is a licensed professional engineer with registration in AL, GA, NC and SC. He was also recently named a 2026 Fellow of ASM International (FASM). Currently employed as a Technical Fellow with Blue Origin (Merritt Island Rocket Park), Tom's duties include failure analysis, material characterization, and materials/coatings characterization primarily for the New Glenn rocket, Blue Origin's heavy-lift orbital launch vehicle that stands nearly 98 meters tall. Tom recently completed a 3-year term as a board member of the Failure Analysis Society (FAS) within ASM International, and each year he plans/chairs sessions for the Failure Analysis symposium at IMAT. He is a member of ASM International's IDEA Committee (Inclusion, Diversity, Equality, and Awareness). He enjoys giving public lectures regarding the space industry as well as meeting with university students for career planning.