Seminar Talk

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Friday, September 11, 2015
3:00 p.m. KH 224

Title: Ionizing Radiation Detection Using Microstructured Optical Fiber.

Abstract:
Ionizing radiation detecting microstructured optical fibers are fabricated, modeled and experimentally measured for X-ray detection in the 10-40 keV energy range. These fibers operate by containing a scintillator material which emits visible light when exposed to ionizing radiation. An X-ray source characterized with a CdTe spectrometer is used to quantify the X-ray detection efficiency of the fibers. The solid state CdTe detector is considered 100% efficient in this energy range. A liquid filled microstructured optical fiber (MOF) is presented where numerical analysis and experimental observation leads to a geometric theory of photon transmission using total internal reflection. The model relates the quantity and energy of absorbed X-rays to transmitted and measured visible light photons. Experimental measurement of MOF photon quantities show good quantitative agreement with calculated theoretical values. This work is extended to a solid organic scintillator, anthracene, which shows improved light output due to its material properties. A detailed description of the experimental approach used to fabricate anthracene MOF is presented. The fabrication technique uses a modified Bridgman-Stockbarger crystal growth technique to grow anthracene single crystals inside MOF. The anthracene grown in the MOF is characterized using spectrophotometry, Raman spectroscopy, and X-ray diffraction. These results show the anthracene grown is a high purity crystal with a structure similar to anthracene grown from the liquid, vapor and melt techniques. The X-ray measurement technique uses the same approach as that for liquid filled MOF for efficiency comparison. A specific fiber configuration associated with the crystal growth allows an order of magnitude improvement in X-ray detection efficiency. The effect of thin film external coatings on the measured efficiency are presented and related to the fiber optics. Lastly, inorganic alkali halide scintillator materials of CsI(Tl), CsI(Na), and NaI(Tl) are grown as single crystals inside the MOF. These alkali halide fibers show an improvement in X-ray detection efficiency comparable with the CdTe detector and can be more efficient, dependent upon the photon counter efficiency and fiber configuration. The fiber configuration for this improved efficiency is described as the same for the higher efficiency anthracene MOF.

Bio:

Dr. DeHaven received his PhD degree in Electrical Engineering from Old Dominion University in 2014. Additional degrees are the MEEE from Old Dominion University in 2001 and the MSME and BSME degrees in 1987 and 1984, respectively, from the University of Kentucky. He has performed systems engineering work at Newport News Shipbuilding from 1988-1991 and process systems engineering with wind tunnels at NASA Langley from 1991-2002. A professional engineer's license was received in 1998. He has published seven conference papers and three journal papers and has one patent. He currently performs fiber optics sensors research and development at NASA Langley with research interests including sensor technologies for nondestructive testing.