APPLICATION OF ELECTRON PARAMAGNETIC RESONANCE IMAGING TO THE CHARACTERIZATION OF ULTEM^R EXPOSED TO 1-MeV ELECTRONS. CORRELATION OF RADICAL DENSITY DATA TO TIGER CODE CALCULATIONS.

N. K. SULEMAN*
Assistant Professor, Department of Chemistry, Hampton University
Hampton, Virginia 23668

A major long-term goal of the Materials Division at the NASA Langley Research Center is the characterization of new high-performance materials that have potential applications in the aircraft industry, and in space. The materials used for space applications are often subjected to a harsh and potentially damaging radiation environment. The present study constitutes the application of a novel technique to obtain reliable data for ascertaining the molecular basis for the resilience and durability of materials that have been exposed to simulated space radiations.

The radiations of greatest concern are energetic electrons and protons, as well as galactic cosmic rays. Presently, the effects of such radiation on matter are not understood in their entirety. It is clear however, that electron radiation causes ionization and homolytic bond rupture, resulting in the formation of paramagnetic spin centers in the polymer matrices of the structural materials. Since the detection and structure elucidation of paramagnetic species are most readily accomplished using Electron Paramagnetic Resonance (EPR) Spectroscopy, the NASA LaRC EPR system was brought back on-line during the 1991 ASEE term [1]. The subsequent 1992 ASEE term was devoted to the adaptation of the EPR core system to meet the requirements for EPR *Imaging* (EPRI), which provides detailed information on the *spatial* distribution of paramagnetic species in bulk media [2].

The present (1994) ASEE term was devoted to the calibration of this EPR Imaging system, as well as to the application of this technology to study the effects of electron irradiation on Ultem^R, a high performance polymer which is a candidate for applications in aerospace. The Ultem^R was exposed to a dose of 2.4 $\times 10^9$ Rads (1-MeV energy/electron) at the LaRC electron accelerator facility. Subsequently, the exposed specimens were stored in liquid nitrogen, until immediately prior to analyses by EPRI. The intensity and dimensions of the EPR Images that were generated for the irradiated specimens showed that the electrons penetrated the material to a depth of approximately 0.125 inch. These data show a very high degree of correlation to the energy deposition profile as predicted by the Tiger Code [3], a Monte Carlo code that provides guidelines for the transport of electrons in matter. Subsequent efforts will focus on delineating the transport properties of energetic protons in Ultem^R.

References

1. Suleman, N. K. *NASA Contractor Report* # 187598, **1991**, 213.
2. Suleman, N. K. *NASA Contractor Report* # 189691, **1992**, 185.
3. Halbleib, J.; Mehlhorn, T,; Kensek, R. *TIGER P, Version 2.1*; **1987**, Sandia National Laboratories.

*Present Address: Dept. of Chemistry, University of Guam, Mangilao, Guam 96923, USA.