

CHARACTERIZATION OF RADIATION-INDUCED DAMAGE IN HIGH PERFORMANCE POLYMERS BY ELECTRON PARAMAGNETIC RESONANCE IMAGING SPECTROSCOPY

by

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At present, the potential for long-term human activity beyond the Earth's protective magnetosphere is limited in part by the lack of detailed information on the effectiveness and performance of existing structural materials to shield the crew and spacecraft from highly penetrating space radiations. The two radiations of greatest concern are high energy protons emitted during solar flares and galactic cosmic rays which are energetic ions ranging from protons to highly oxidized iron [1-3].

Although the interactions of such high-energy radiations with matter are not completely understood at this time, the effects of the incident radiation are clearly expected to include the formation of paramagnetic spin centers via ionization and bond-scission reactions in the molecular matrices of structural materials. Since this type of radiation damage is readily characterized by Electron Paramagnetic Resonance (EPR) spectroscopy [4], the NASA Langley Research Center EPR system was repaired and brought on-line during the 1991 ASEE term.

A major goal of the 1992 ASEE term was to adapt the existing core of the LaRC EPR system to meet the requirements for EPR Imaging--a powerful new technique which provides detailed information on the internal structure of materials by mapping the spatial distribution of unpaired spin density in bulk media [5,6]. Major impetus for this adaptation arises from the fact that information derived from EPRI complements other methods such as scanning electron microscopy which primarily characterize surface phenomena.

The modification of the EPR system has been initiated by the construction of specially designed, counterwound Helmholtz coils which will be mounted on the main EPR electromagnet. The specifications of the coils have been set to achieve a static linear magnetic field gradient of 10 gauss/mm/amp along the principal (Z) axis of the Zeeman field.

Construction is also in progress of a paramagnetic standard in which the spin distribution is known in all three dimensions. This sample will be used to assess the linearity of the magnetic field gradient and to ensure authentic image reconstruction.

A second major task was to secure the computer capability to enable image reconstruction from projection data generated by the magnetic field gradients. To this end, commercially available and public domain software packages which perform inverse Fourier Transform and convoluted (filtered) back projection functions are being integrated into the existing EPR data processing system.

References

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