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UV Curing Polymers For Radiation Shielding Applications

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Abstract: The scope of the current research is to develop polymers that will be durable under space conditions. In space, polymers can undergo thermal, mechanical, and oxidative degradation depending on which direction in space they are rotated (ram, wake, zenith, or nadir). Polymers can also be synthesized using techniques such as UV-radiation curing[1,2] and cross-linking. In the current project, three organic molecules, acrylamide, styrene-butadiene, and triethylene glycol divinyl ether, were studied using computational software called OLTARIS[3] (On-Line Tool for the Assessment of Radiation In Space) developed by NASA Langley to predict the degree of radiation shielding. All three molecules showed shielding before 60 g/cm^2 areal density.

Objectives

1. Determine the degree of galactic cosmic radiation shielding in humans by way of cancer detection from each material by using OLTARIS.
2. Determine the degree of galactic cosmic radiation shielding in humans by way of leukemia detection from each material by using OLTARIS.

Approach

1. The OLTARIS computational code was used as an algorithm for three UV-cured polymers (polyacrylamide, styrene-butadiene, and triethylene glycol divinyl ether).
2. OLTARIS is based on the HZETRN2005 and NUCFRG2 codes.
3. The parameters for the assessments were:
    a. Galactic cosmic rays
    b. Badhwar-O'Neill 2020 model
    c. 2010 Solar Minimum
    d. NASAQ quality factor

STRUCTURES AND MATERIALS
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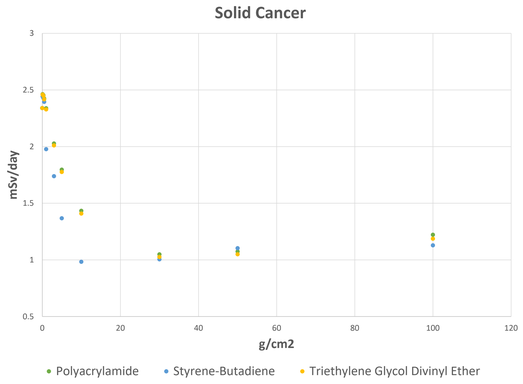
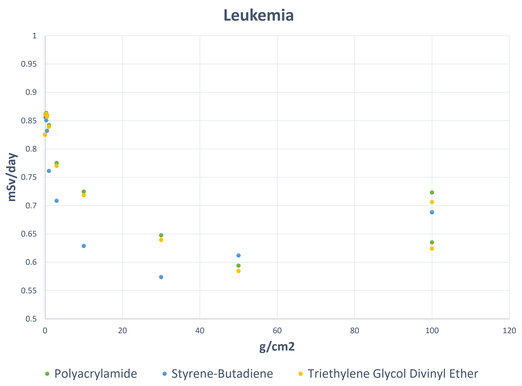
Results: OLTARIS





Discussion/Conclusion

All three polymers are deemed suitable for galactic cosmic radiation shielding in space to about a thickness of 60 g/cm^2. After this thickness, the shielding decreases and an increase of dose is seen in all three polymers, possibly due to secondary radiation being produced from nuclei.

Future Work

Hydrogen optimization studies need to be performed to differentiate which polymer would be the most effective in space.

References

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2. Decker, Christian; et al.: Polymer. "Synthesis of Nanocomposite Polymers by UV-Radiation Curing." 46 (2005) 6640-6648.
3. Singleterry, Robert C., Jr.; Blattnig, Steve R.; Clowdsley, Martha S.; Qualls, Garry D.; Sandridge, Christopher A.; Simonsen, Lisa C.; Norbury, John W.; Slaba, Tony C.; Walker, Steven A.; Badavi, Francis F.; Spangler, Jan L.; Aumann, Aric R.; Zapp, E. Neal; Rutledge, Robert D.; Lee, Kerry T.; and Norman, Ryan B.: OLTARIS: On-Line Tool for the Assessment of Radiation in Space. NASA/TP-2010-216722.