MASTERBOND®
CASE STUDY

EP39MHT: Utilized to mount magnets in a linear particle accelerator to extract the neutron form factor

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EP39MHT: Utilized to mount magnets in a linear particle accelerator to extract the neutron form factor

Overview of EP39MHT

Master Bond EP39MHT is a two-component, low-viscosity epoxy resin system that can be cured at room temperature and can withstand rigorous thermal cycling, vibration, and shock. It is suitable for high-performance bonding and sealing applications, such as for mounting samarium-cobalt magnets at the Bates Research and Engineering Center (formerly known as the Bates Linear Accelerator Center) at MIT to probe electron-neutron interactions.

Application

Deuteron (the nucleus of deuterium, an isotope of hydrogen) is the simplest nuclear system and contains only one proton and one neutron. It is especially useful for probing nucleon-nucleon interactions due to the weak binding between its single proton and neutron, which allows the proton and neutron to be treated as free particles. When irradiated with electrons in a particle accelerator, inelastically scattered electrons can be detected and compared with those scattered by a hydrogen atom to determine the neutron's size. The neutron magnetic form factor, G^n_M, can be extracted to provide information about the internal structure of the neutron. Such investigations are performed in a particle accelerator, which requires strong, temperature-stable sextupole magnets to control chromatic aberrations. In a Ph.D. thesis at the Massachusetts Institute of Technology (MIT), one researcher used EP39MHT to mount new sextupole magnets for use in the Bates Large Acceptance Spectrometer Toroid (BLAST) of the MIT-Bates Linear Accelerator.

Key Parameters and Requirements

The author mounted samarium-cobalt sextupole magnets in the MIT-Bates Linear Accelerator in a 0.3 mm stainless steel inner wall in a vacuum chamber after covering most of their surface area with EP39MHT. The chamber was then pumped down to allow any air bubbles from the epoxy application to escape and improve the vacuum seal. The service temperature range of EP39MHT is -100°F to +400°F, which makes it suitable for withstanding the high temperature (> 100°C) generated by activation of the NEG pumps used to sustain the vacuum in the top sextupole chamber.

At Master Bond, the recommended cure schedule is at 3–4 days at room temperature or heat curing for 3–4 hours at 150–200°F. The optimal cure schedule is an overnight cure at room temperature, followed by 2–4 hours at 150–200°F.

Results

As part of their experiments, sextupole magnets were used at BLAST in the beginning, but they showed a lower-than-expected magnetic strength. Therefore, new samarium-cobalt magnets with improved thermal tolerance were ordered and mounted in a 0.3 mm stainless steel inner wall using Master Bond EP39MHT. As noted by the author, EP39MHT was chosen because of "its low outgassing and good sealing performance." The author first collected a background signal from the cell's wall to determine the electrons scattered from it using an empty target. These data were used to determine Q^2 for each scattering event using the scattering angle and momentum of the reconstructed electron. Then, the neutron magnetic form factor G^n_M was extracted by comparing the background-corrected experimental ratio of the asymmetries to the value calculated using Monte Carlo simulations. The obtained G^n_M values were in good agreement with those reported by previous authors, providing invaluable information about the structure of the neutron. Master Bond EP39MHT ensured that the new magnets remained securely mounted at the high temperatures (> 100°C) used during these investigations.

References

Meitanis, N. (Nikolas C.). A Measurement of the Neutron Magnetic Form Factor G^n_M from Quasi-elastic^2[right arrow]H ([right arrow]e, e') at low Q^2. Thesis, Massachusetts Institute of Technology, 2006. https://dspace.mit.edu/handle/1721.1/37212.