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Mechanical Performance of Irradiated Adhesive Samples for ATLAS ITk

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One of the most mission-critical adhesive applications in ATLAS ITk, and indeed in any modern silicon tracker, is in the construction of the local supports and their interfaces to the detector modules. Adhesives in this application must bond to a variety of surfaces, including carbon and silicon, and embody a complex combination of traits in modulus, thermal conductivity, and reworkability. A favorite for this application is Dow Corning SE4445. However, this silicone-based thermal potting compound had never been rigorously strength tested under the irradiation levels expected to be encountered during high luminosity operation of the LHC. Its un-irradiated behaviour is visco-elastic, and does not suggest high radiation resistance. The authors therefore created standard 2cm square test coupons, of both silicon and carbon bonded together with both SE4445 and a range of other currently used adhesives. These coupons were irradiated, 300 in total, to levels of 5, 10, and 15 MGy. They were then bonded to thick-adherend single lap shear test coupons, which were pull tested to failure. The results conclusively prove that not only does SE4445 reliably exhibit shear strengths in excess of 6 MPa at 15 MGy, but it also transitions from a visco-elastic compound to an elastic solid with a well-defined shear modulus, with an improvement in overall structural performance. This study clears the way for SE4445 to be used in the LHC phase-2 upgrade without risk of radiation induced failure, even at the highest dose levels.

Authors: DENOS, Ben (Purdue University (US)); HARTMAN, Neal David (Lawrence Berkeley National Lab. (US)); CLAYBAUGH, Todd (Lawrence Berkeley National Lab. (US))

Presenters: HARTMAN, Neal David (Lawrence Berkeley National Lab. (US)); CLAYBAUGH, Todd (Lawrence Berkeley National Lab. (US))

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