

PEEK Tube/Core Studies

J. Fast, D. Olis, G. Lanfranco,
H. Jostlein, B. Nitti, R. Duncan
K. Schultz, T. Nebel, R. Davis

Heat Transfer Measurements

- Tubing formed to 5.4mm x 2.0mm outside dimensions was assembled into a core structure with CF skins.
- Heaters were placed on the skins at the SVX chip locations and several RTDs were used to measure the CF skin temperature at various locations.
- An ANSYS model of this mock-up was built and the results compared with the FEA model.
- The measured heat transfer coefficient^[1] was 650 W/m²K.
- ^[1] \\ppd88354\SiDetEng\PEEK Testing\Heat transfer study on D0 Run2b stave.pdf
\\ppd88354\SiDetEng\PEEK Testing\Pressure Drop in D0 Run2b Stave.pdf

Thermal FEA of PEEK Stave

- Tube geometry of 6.88mm x 2.0mm (OD), very close to the shape we are producing now (7.0mm x 1.9mm) and with
- A 0.225mm epoxy/Kapton layer was used under the sensors.
- A heat transfer coefficient of 695 W/m²K was used, based on scaling the measured value to the new geometry.
- Coolant bulk temperature of -14C was used.
- The maximum silicon temperature in the FEA[1] was -1.4C.
- Frank Lehner[2] : depletion voltage in L2 operating at +10C is ~150V with a signal to noise ratio >10:1 for T=+5C at 15fb-1.
- ⇒ delivery of -10C fluid would not noticeable degrade performance.
- [1] \\ppd88354\SiDetEng\PEEK Testing\FEA - staves analysis.pdf
- [2] D0NOTE 3959, draft 5.0

Adhesion Tests

- Shear strength of PEEK to PEEK joints with 0.003” glue lines. Renee Duncan[\[1\]](#) and Ben Nitti[\[2\]](#) both performed these measurements, with different adhesives. The main thrust was to evaluate adhesion of PEEK nuts to hybrids.
- Measured 415-815psi using 3M 2216 adhesive
- Measured 213-645psi using Ablebond 84-3 adhesive, a product one of the hybrid stuffing vendors.
- The lower values represent adhesive failures due to poor surface preparation while well prepared surfaces show cohesive failure with shear strengths >400psi generally.
- [\[1\]](#) \\ppd88354\SiDetEng\PEEK Testing\SIST Final Paper - 2a.pdf
- [\[2\]](#) \\ppd88354\SiDetEng\PEEK Testing\Adhesive Test Results Eng Note.pdf

Leak Checking PEEK Tubes

- PEEK is rather permeable to He
- PEEK tube collapses under vacuum
- Use “reverse vacuum” test with Ne
 - Put tube in evacuated vessel
 - Backfill tube with Ne to 15psia
 - Leak detector tuned to Ne measures leak rate to vessel
- Measured first 6 PEEK tubes, 7.0mm x 1.9mm
 - Peak leak rate was $1.5\text{-}6.4 \times 10^{-5}$ STD-cc/sec
 - Tube starts to “clean up” after ~5 min
 - More investigation required
 - Time evolution of leak rate and pulsed Ne could improve sensitivity

Bubble Clearing

- Cooling system runs below atmosphere so leaks suck air in, rather than leaking fluid out.
- Hans investigated whether tubes would collect bubbles and become blocked, or would clear them.
- Glycol/water at room temp, 0%-100% solutions
 - Match viscosity, maximize surface tension etc.
- Bubbles cleared at flows below 60cc/min
 - Design flow is 175cc/min

Irradiation Tests

- Round (D~0.2”) tube samples, 0.004” wall
- Six samples irradiated to 18 Mrad at the booster.
- Six control samples not irradiated.
- Tubes were pressurized to failure.
- Failure pressures for irradiated samples were 525-570psi and for control samples 520-625psi [\[1\]](#).
- [\[1\]](#) \\ppd88354\SiDetEng\PEEK Testing\Irradiation Test Results.pdf

Formed Tube Burst Tests

- Two of the worst looking formed U-tubes we had made were tested to failure with internal pressurization.
- Failures occurred at 95psi and 97psi.

Stave Core Vacuum/Pressure Tests

- Assembled cores with 0.003” Kapton MT skins.
- Measured deflection at the center of the tube span vs. pressure.
- Pressure range of 10-35psia (-5 to +25 psig).
- Slope is 0.002”/psi with both positive and negative pressures.

Other Tests

- Long-term flow
 - Five PEEK tubes have been in the system for several months with no indication of degradation.
- Moisture expansion
 - A tube from the long-term test was instrumented with fiducials and the length measured at saturation and dry
 - Length change was $0.022 \pm 0.008\%$ ($122 \mu\text{m}/550\text{mm}$)
- Thermal expansion
 - Calculated from published data: 0.093% for $\delta T = 30\text{C}$