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NAA Acrylic Contamination Tests in the Cavity

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We report here on contamination tests on two acrylic samples. The object of the first test was to determine the contamination that may remain after the sanding and cleaning of bonds. The second test was to determine the contamination level of a bond made in-situ in the ramp clean room.

I. TEST OF SANDING CONTAMINATION

Sample Preparation and assay:

An 8" wide by 24" long piece of 2" thick acrylic was taken inside the tent which had been constructed around one of the finished chimney pieces for dust containment during sanding. The acrylic sample was propped up vertically on its 8" by 2" edge. A 2" wide area on the top of both optical surfaces was sanded for approximately 15 minutes simulating the actual sanding procedure followed for the chimney bonds. A series of sanding discs of increasing grades (i.e. decreasing abrasive particle sizes) were used on the mechanical sander with water cooling provided by a squirt bottle. The abraded acrylic and any abrasive that came off the sander ran down and congealed on the exposed unsanded acrylic surfaces. Further, the acrylic test piece was left exposed inside the tent for the rest of the shift (approximately 4 hours) so that dust from further chimney sanding would deposit on its surfaces.

The test piece was wrapped and brought back to CRL, where the acrylic cleaning procedure was simulated. The piece was stood vertically in a sink and ultrapure water (UPW) from the CRL Millipore system was allowed to trickle down from the top of the surfaces. As this did not remove the congealed dust on the surfaces, they were further cleaned by gently wiping with clean, wet lint-free paper wipes. Approximately 1 gallon total of UPW was used in the cleaning procedure. The sanded portion of the test piece was then cut off from the rest of the "clear" acrylic and samples for NAA were prepared separately from the sanded and clear pieces for neutron activation analysis (NAA). A dedicated table saw for acrylic radio-assay was used for the cutting procedures.

Standard activation and counting procedures were used for the assay. Each sample of approximately 900 g was irradiated in the high flux region of the NRU reactor with at least two sealed monitors containing known µg amounts of U and Th. After irradiation, all non-optical surfaces were machined off to eliminate surface contamination due to handling. The samples were then vaporized in an oven to reduce their mass. The residues in the suprasil quartz oven tubes were rinsed out with a warm HF-HNO₃ mixture into small vials for γ-ray counting in the CRL well-type Ge detector. The test samples were counted for at least 24 hours, preceded and followed by short counts of the sealed monitors in identical geometries. The 228.2-keV (10.7% B.R.) line from ²³⁹Np was monitored for the ²³⁸U content, and the 312-keV (36% B.R.) line from ²⁷d ²³³Pa for the ²³²Th content. Separate peak and background regions of interest were set in the γ-ray energy spectrum based on energy calibration and the monitor spectra. The U and Th contents (or 2-σ upper limits) were obtained by directly scaling sample count-rates to monitor count-rates normalized to their known U and Th contents. A wealth of previous data has proven the efficacy of this procedure for the ²³⁸U and ²³²Th assay of acrylic (and other organic) samples.

Results

- 1) Clear portion of sanded acrylic block - I.D.: #306, 11-Sep-95.

Dimensions: 2 11/16" x 2" x 8"

Total optical surface area = 32 in² or 200 cm²

Net weight after machining = 803 g

Measured contamination:

$$[^{238}\text{U}] \leq 3.7 \times 10^{-12} \text{ g/g (2-}\sigma \text{ Upper Limit)}$$

$$[^{232}\text{Th}] \leq 0.3 \times 10^{-12} \text{ g/g (2-}\sigma \text{ Upper Limit)}$$

- 2) Sanded portion of sanded acrylic block - I.D.: #307, 11-Sep-95.

Dimensions: 2 11/16" x 2" x 8"

Total optical surface area = 32 in² or 200 cm²

Net weight after machining = 860 g

Measured contamination:

$$[^{238}\text{U}] \leq 2.0 \times 10^{-12} \text{ g/g (2-}\sigma \text{ Upper Limit)}$$

$$[^{232}\text{Th}] \leq 0.3 \times 10^{-12} \text{ g/g (2-}\sigma \text{ Upper Limit)}$$

II. IN-SITU ACRYLIC BOND

Sample Preparation:

Two pieces of 2" thick acrylic were bonded in the ramp clean room. The bonded piece was transported to CRL, where a sample was cut which contained the bond. This sample was irradiated and prepared for γ -ray counting by the procedures outlined in the previous section.

Results

- 2) In-situ bond - I.D.: #308, 27-Sep-95.

Dimensions: 1" x 2 1/4" x 8"

Total optical surface area = 16 in² or 100 cm²

Weight = 572 g

Measured contamination:

$$[^{238}\text{U}] \leq 3.7 \times 10^{-12} \text{ g/g (2-}\sigma \text{ Upper Limit)}$$

$$[^{232}\text{Th}] \leq (11 \pm 0.5) \times 10^{-12} \text{ g/g}$$

III. CONCLUSIONS

- 1) The results from the sanding tests show that any sanding residues can apparently be washed off because no contamination above background is seen. The limits set on the U and Th levels are within tolerances. These results are certainly encouraging as far as final cleaning of the acrylic vessel is concerned.

2) A $20\text{-}\sigma$ signal for Th contamination is seen in the bond sample. The measurement may be reinterpreted as 9.45 ng Th per foot of bond. Thus the total Th in the bonds may be compared to the specifications for total Th in the acrylic vessel. It may also be desirable or germane to pursue and eliminate the source of this contamination in the acrylic bonds.