NAA Acrylic Contamination Tests in the Cavity

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 2.3 d ²³⁹Np
was monitored for the ²³⁸U content, and the 312-keV (36% B.R.) line from 27 d 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:

   Dimensions: 2 11/16" x 2" x 8"
   Total optical surface area = 32 in² or 200 cm²
   Net weight after machining = 913 g
   Measured contamination:
   \[ [238U] \leq 3.7 \times 10^{-12} \text{ g/g (2-\sigma Upper Limit)} \]
   \[ [232Th] \leq 0.3 \times 10^{-12} \text{ g/g (2-\sigma Upper Limit)} \]

   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:
   \[ [238U] \leq 2.0 \times 10^{-12} \text{ g/g (2-\sigma Upper Limit)} \]
   \[ [232Th] \leq 0.3 \times 10^{-12} \text{ g/g (2-\sigma Upper Limit)} \]

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 ample was irradiated and prepared for \( \gamma \)-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:
   \[ [238U] \leq 3.7 \times 10^{-12} \text{ g/g (2-\sigma Upper Limit)} \]
   \[ [232Th] \leq (11 \pm 0.5) \times 10^{-12} \text{ g/g} \]

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-σ 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.