# Measurement of Mine Dust Deposited on Sanded Acrylic Surfaces under Bonding Conditions at the 4600' Laboratory

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**Abstract:** The mine dust deposited on sanded surfaces of test samples in the acrylic bonding exercise of March, 1992 was found by x-ray fluorescence analysis to be 0.05 (+0.07, -0.05) $\mu g/cm^2$. This is well below the level at which mine dust in bonded joints would present a problem for SNO. The efficiency of the adhesive tape used in the XRF analysis for the removal of mine dust from a sanded surface has been measured and found to be greater than 90% (fraction of mass).

## I. Introduction

Mine dust trapped in the bonded joints of the acrylic vessel represents a source of radioactive background that, like thorium in the bulk acrylic, cannot subsequently be removed by cleaning. It is a source of background that can be minimized or eliminated, however, and the SNO collaboration has been concerned with this potential problem since the inception of the project. This was one of the motivations for determining as early as possible the amount of contamination by mine dust and other sources of Th to be expected in the bond joints. This was to be done by actually bonding joints underground under conditions that would be representative of actual construction conditions. The bonded joints would then be excised from the sample and subjected to mass spectrometry in the same manner used to determine U and Th in bulk acrylic. It seemed worthwhile to us to try to isolate and measure the contribution of mine dust to the total amount of Th that might be present in the bonded joint. We proposed an additional test that would enable such a measurement, and this request was accommodated by the acrylic vessel group.

We report here on measurements of the mine dust deposited in bond joints of two acrylic test samples included in the 4600' level bonding tests during the first week of March, 1992.

## II. Procedure

The test samples were prepared and handled similarly to those that were actually bonded. However, when the bonding agent was put into the gaps between the other samples, the sanded surfaces of the test samples were brought together and sealed with tape so that no additional dust could be deposited. The test samples were 6"x6"x2", with the sanded surface being 6"x2". The procedures followed in the bonding exercise have been described in detail by D. Earle[1]. A description of the 4600' laboratory and summary of the events of this week have been given by D. Hallman, et al.[2]

In brief, the test samples were set up for bonding in an area of the laboratory where they were considered likely to pick up as much or more dust than the samples that were actually bonded. They were subjected to the same cleaning procedure underground, viz. a wipe with a solution of 20% isopropanol followed by Kimwipes saturated with inhibited monomer. After a period of time, about 27 minutes[1], during which the bond joint was exposed to ambient air in the laboratory, the opposing surfaces forming the bond gap were brought together, sealed with tape and the samples bagged. This transpired on March 7, 1992. We received the bagged samples from D. Hallman in Toronto on March 11. The samples were unpacked on March 17 in the LBL clean room on a laminar flow clean bench (under Class 10 conditions) and inspected visually under strong oblique light and with a fifty power microscope.

Visual inspection of the surfaces suggested a uniform level of cleanliness over the entire sanded surface. Using only the naked eye and strong oblique light, we could see dust, some of which was obviously fibers. Adhesive tape was applied to the sanded surface, lifted, and mounted for subsequent analysis with x-ray fluorescence spectrometry (XRF). After removing the tape we could see, under oblique light, a roughly-defined boundary where the lifted tape had removed the surface contamination. The acrylic control samples (cleaned at Laurentian U. but not brought down into the mine) appeared similar to the naked eye.

## III. Results

The XRF analysis of a tape lift from several square centimeters of surface in the middle of the 6"x2" sanded surfaces of each sample from the 4600' level indicated a total of 0.05 (+ 0.07, -0.05) $\mu g/cm^2$

of mine dust (assuming a 6% Fe component in mine dust). This is the amount obtained by summing the contributions from both surfaces. The error is one standard deviation.

This analysis assumes that the adhesive tape removes 100% of the mass of the dust from the machined and sanded surface. A measurement of the efficiency of the tape for removing particles as a function of particle size is described in the appendix.

Comparably small values were observed on tape lifts taken from the 6"x6" smooth surfaces of one of the samples. Tape lifts taken from the control sample have not been analyzed by XRF because of the absence of significant mine dust on the samples from the 4600' level.

The upper limits for the level of mine dust on the surface of the acrylic test samples are 0.12 $\mu g/cm^2$ (one sigma) or 0.26 $\mu g/cm^2$ (three sigma). These results were communicated to the acrylic vessel group on March 18, 1992.

These amounts of mine dust can be put in context by calculating the Th they contain, and comparing to the amounts contributed by the bonding agent and by the entire vessel if the latter have 1 ppt of Th. A value of 0.05 $\mu g/cm^2$ of mine dust (at 5 ppm of Th) corresponds to $0.25 \times 10^{-12}$ $g/cm^2$ of Th. A 3 mm thick bond joint would have a comparable amount, $0.36 \times 10^{-12}$ $g/cm^2$. If the total amount of mine dust on both surfaces were to be *forty* times higher, i.e., 2 $\mu g/cm^2$, then the amount of Th in the bonded joints arising from mine dust would still be only 5% of the total amount of Th in the acrylic vessel. This implies that there would not be a problem if the time during which the joint is exposed to air under actual bonding conditions were longer than a half hour.

## IV. Conclusion

Mine dust in bond joints will not contribute significant background radioactivity if the ambient air is HEPA-filtered and only a few hours elapse between cleaning the surface of the joint and insertion of the bonding agent. This conclusion should be checked by similar measurements in the cavity during actual bonding.

# Appendix

## Efficiency of Adhesive Tape for Removing Mine Dust from Sanded and Smooth Surfaces

### I. Introduction

Adhesive tape provides a convenient way of transporting dust from a surface to an analytical device. Furthermore, because the tape can be thin, it contributes a minimum background to an XRF measurement. The efficiency of an adhesive tape for removing dust particles is high provided the adhesive material comes in contact with the dust. We know from experiments with adhesive tape applied to *smooth* surfaces that the efficiency is close to 100%. However, it is not clear how effective the tape is for removing particles from a *sanded* surface. A sanded surface is, at some level, rough, and the particles of dust residing in the bottoms of the sanding grooves may not come in contact with the adhesive medium of the tape. The tape we use (3M, No. 369) is 37 microns thick (backing plus adhesive medium) and the grooves in the sanded surface average about 23 microns in depth. We decided it was necessary to measure the efficiency of adhesive tape for removal of mine dust from sanded acrylic surfaces.

### II. Procedure

We used acrylic samples provided us by RPT. They were 2"x3"x1/4" in size and had been sanded on one side as if the surfaces were to be bonded. Using a microscope, we compared these sanded surfaces with those on the samples used in the bonding exercise at the 4600' laboratory. The surfaces were similar, with the samples used for this efficiency test having, if anything, somewhat deeper grooves. The other side of the sample was relatively smooth.

A layer of mine dust about 7 $\mu g/cm^2$ was deposited from air onto the surface of the samples in the manner described in ref. 3. Adhesive tape was applied to half of the surface and then removed. Figures 1 and 2 show a sanded surface and an unsanded surface, respectively in the border area where the edge of the tape was applied. The dust particles show up as bright spots of light. The grooves in the sanded surface are apparent in Fig. 1. The magnification was x60. One sees easily with the microscope that the efficiency for removing particles is quite high. Contrast problems with photography and copying make this less evident in Fig. 1.

The number of dust particles versus size was then determined by scanning the surface with an optical microscope using x100 magnification. Scans were made in adjacent areas on each side of the border defined by the edge of the tape. This was also done for a smooth, unsanded acrylic surface. The results of these scans for a sanded surface are shown in Figs. 3 and 4. Fig. 4 is the result of a scan in an area of the sanded surface where the tape has been applied and lifted. Least-squares fits to the measured particle distributions are also shown in these figures. A comparison of Fig. 3 and Fig. 4 shows that the tape is more effective in picking up the larger particles of dust.

## III. Results

The efficiency of the tape versus the particle size is best determined by using the least-squares fits to the distributions shown in Figs. 3 and 4. This gives a determination of efficiency for any particle size. The results of this are shown in Figs. 5 and 6 for sanded and smooth surfaces. Note that, for particles larger than 10 microns, the efficiencies for removal are similar and greater than 90 percent for smooth and sanded surfaces. Only for particles of 5 microns and smaller in size is there an appreciable difference in efficiency. These observations on efficiency versus particle size seem reasonable given the groove depth.

Since the mass of an approximately spherical particle increases as the cube of its size, most of the mass deposited on the surface resides in the larger particles, for which the efficiency is highest. For the number-size distribution shown in Fig. 3, there is an order of magnitude more mass in the size range 10-50 microns than in the range 1-10 microns. Thus, the efficiency for removal of mine dust from a sanded acrylic surface is greater than 90% of mass initially present on the surface.

## References

1. D. Earle, Trip Report, April 1, 1992
2. "Acrylic Panel Bonding Tests," E.D. Hallman, D.L. Cluff, and D. Cloutier, SNO-STR-92-27.
3. "Contamination Control Study on Mine Dust," E. Kong, SNO-STR-92-49

Fig. 1 Sanded surface

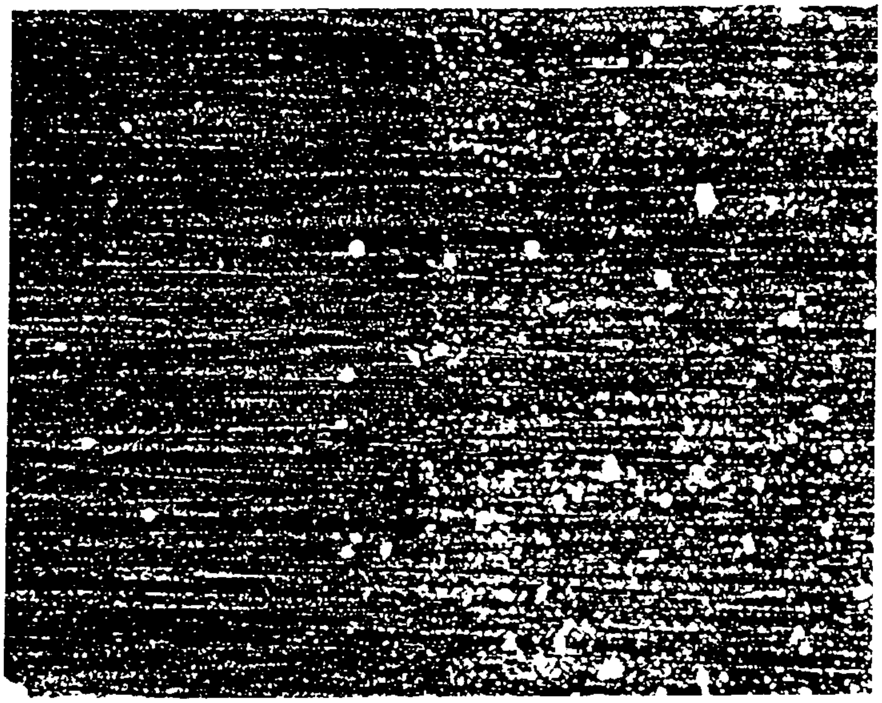

Fig. 2 Smooth Surface

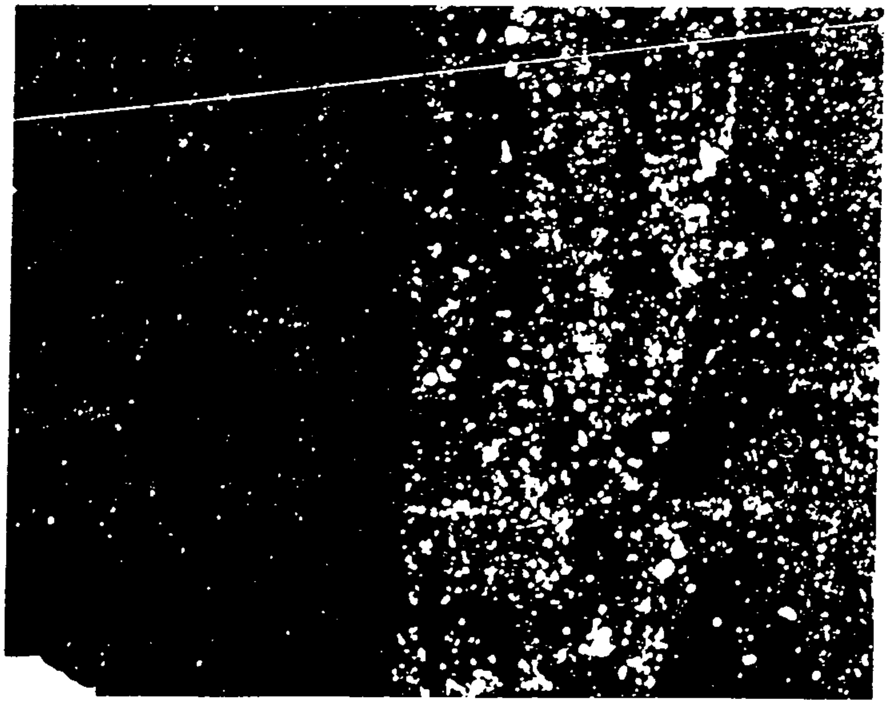

Figure 3. Plot of "Sanded I (dirty)" Counting Result

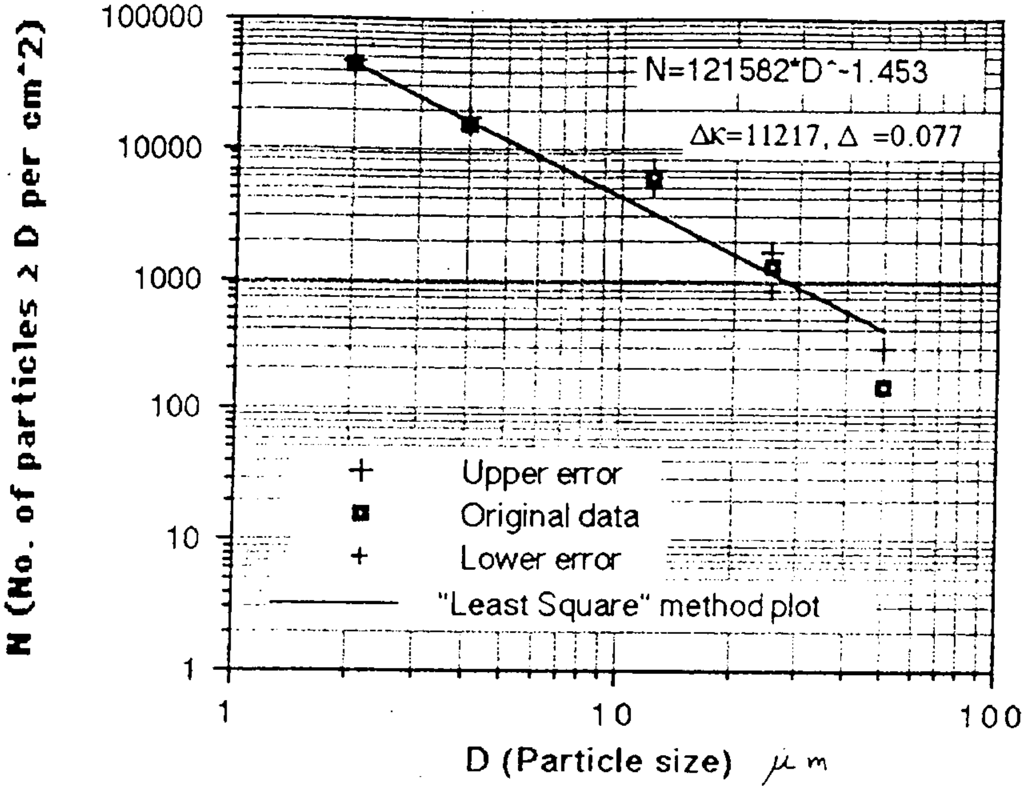

Figure 4. Plot of "Sanded I (clean)" Counting Result

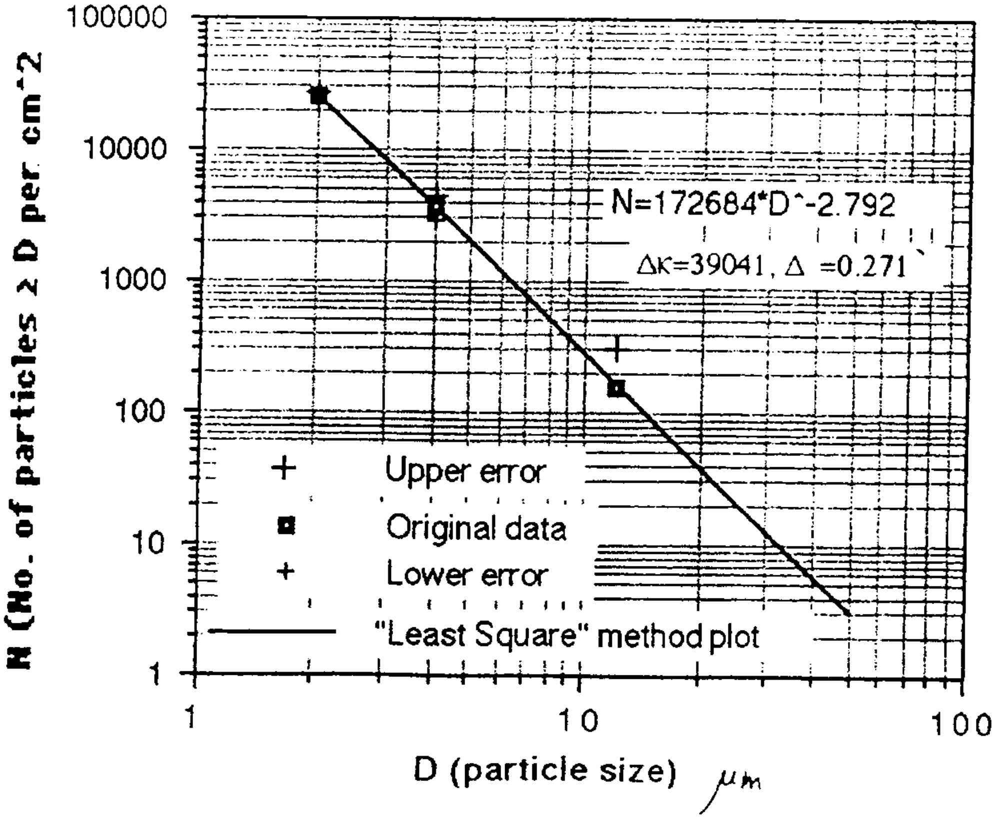

Figure 5. Tape-lift test Efficiency vs. Particles Size (Sanded I)

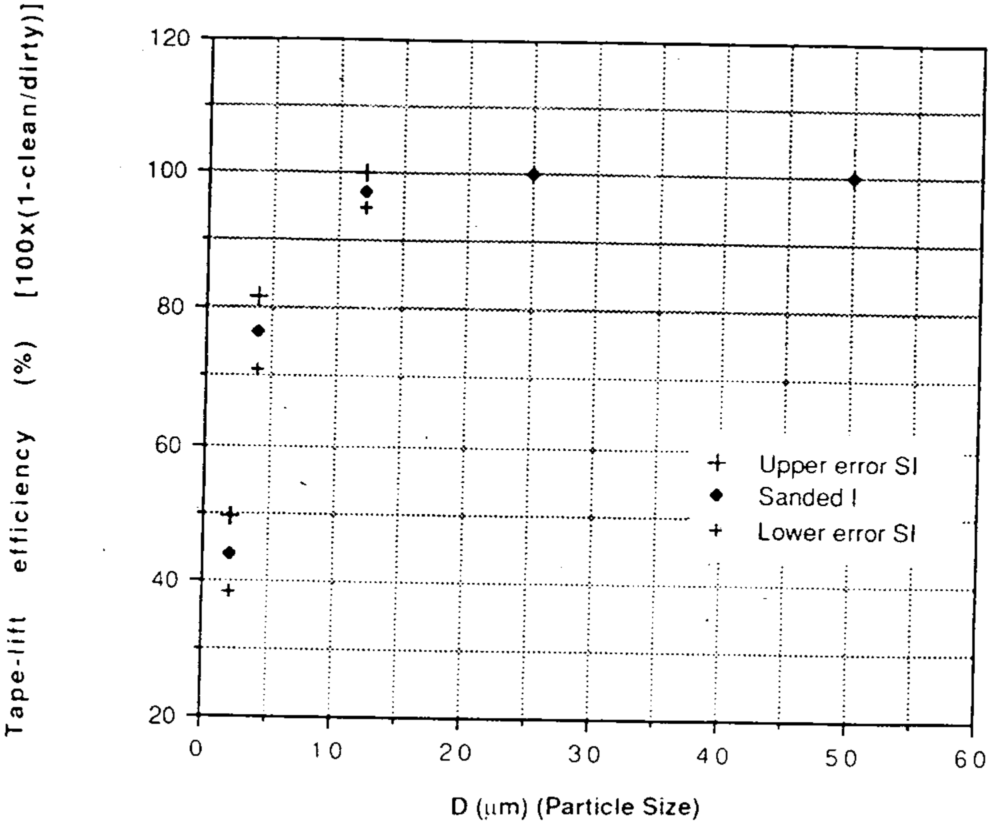

Figure 6. Tape-lift test Efficiency vs. Particles Size (Smooth I)