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LARGE-AREA BORON AND CARBON SCATTERERS AND FILTERS

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ABSTRACT

We have successfully developed a technique for making large-area boron and carbon scatterers or filters for use on nuclear field experiments and in the ion accelerator/subkilovolt x-ray facility in the Lawrence Livermore Laboratory. We made these scatterers and filters by spraying a mixture of boron in ethyl alcohol or of carbon in isopropyl alcohol on a backing material of 0.00185-cm polyethylene ($-\text{CH}_2\text{CH}_2-$). In place of the polyethylene, any suitable backing material can be used.

INTRODUCTION

X-ray scatterers that had a large area (1760 mm^2) were required for a nuclear field experiment. The largest area of free-standing boron or carbon scatterers to date is 500 mm^2 .¹

We found that a variety of thicknesses could be obtained by spraying the appropriate substrate material onto a backing material. The thinnest possible substrate is when the scatterer is just opaque to light. Another method for producing large-area coated scatterers is to immerse the scatterer in boron solution.² This method allows for a much thinner substrate. However, in our particular case, we used the spraying application because the final scatterer holders are ceramic and were to be used as insulators. Also, we wanted to have the coatings on one side only.

EQUIPMENT FOR SPRAYING

The spraying apparatus that we used was a standard Binks No. 059-10003 size "A" air brush. The air source was dry nitrogen pressurized between 20-35 psi. This source keeps both the water vapor and any other contaminants from entering the solution.

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The boron and carbon solutions are easily obtainable from Acheson Industries. The original boron solution was obtained from Williamson and Maxson. (They also included information on where additional samples could be purchased.) The carbon solution came from a spray can of Acheson Aqua Dag. The carbon can also be obtained from jars of Aqua Dag thinned about 2 to 1 with isopropyl alcohol.

PRELIMINARY PREPARATION

Many steps are involved in preparing one of these scatterers. First, the backing material selected should be thick enough so it can be laid down on a surface without breaking while still being attached to a holder. The backing material can be plastic, metal, or any other material that meets the experimenter's requirements.

Next, the backing material is attached to the holder or ring. The procedure that we follow is to glue the backing to the holder with Carboline neoprene adhesive F-1 thinned with Carboline thinner 50-50. The gluing is done by laying the backing material on a flat, dust-free surface and then putting the holder on after it is coated with adhesive. These are then set aside to dry thoroughly.

The scatterer holders are weighed on a Sartorius No. 3400 Digital Analytical Balance. The masks for these particular scatterers were made of paper index cards with a hole cut about 2 to 5 mm smaller than the exposed backing material to eliminate the over-spray.

SPRAYING

For the spraying, we selected the size "A" nozzle Binks air brush after we experimented with three assorted size brushes. The "A" nozzle was the smallest of the three sizes and gave the finest line and smallest droplet size. With a fine line brush, one can make many passes over the scatterer instead of just one or two. This results in a more even, uniform covering. Figure 1 shows the directions and number of passes. If a large nozzle brush is used, the sprayed material will be splotchy and not uniform.

Before spraying on the scatterers we planned to use, a number of practice scatterers were constructed using thick polyethylene. Because of the heaviness of this material, we were able to reuse it many times. The practice holders were weighed before and after the spraying to determine the density of the substrate. When the desired density was reached, we used the actual holders.

Boron scatterers were not made for the field experiment. Only one practice boron scatterer was made, and it had a thickness of 1.027×10^{-3} g/cm². We were not striving at this time to obtain any specific thickness. However, for the carbon scatterer, we wanted a thickness of 2.326×10^{-4} g/cm² $\pm$ 10%.

Table 1 shows the densities we obtained on five carbon scatterers. After completing the five scatterers for a field experiment, we checked their transmission qualities in the 300-kV ion accelerator/subkilovolt x-ray facility. Table 2 lists the transmission results. A completed scatterer and holder is shown in Fig. 2.

ADDITIONAL SCATTERERS

Since October 1978, we have produced thinner scatterers. And as of March 1979, the thinnest substrate used is 5000- and 10 000-Å Paraline N. These scatterers are being used by Jerry Gains on a scatterer evaluation experiment.

CONCLUSIONS

We are able to obtain specific substrate densities on carbon or boron scatterers and filters on backing materials as thin as 5000 Å.

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Legend:

- First pass
- | Second pass
- \ Third pass
- / Fourth pass

Note: The passes must be kept close together. There is no set direction on the passes (left to right or up and down).

After all four passes have been completed, the procedure is to repeat the first or weigh the scatter to check the density.

FIG. 1. The unmasked area of the scatterer and the direction of the different passes.

FIG. 2. Scatterer holder of 45° angle with carbon and polyethylene mounted on a ceramic holder.

TABLE 1. Densities of the five carbon scatterers.

Scatterer No.	Density ($\times 10^{-4}$ g/cm ²)	Percentage from desired density ^a
1	2.264	-2.4
2	2.993	+28.8
3	2.207	-5
4	2.163	-6.8
5	2.207	-5

^aThe desired density was 2.326×10^{-4} g/cm².

TABLE 2. Percentage of transmission two scatterers.

X-ray energy (eV)	Scatterer No. 2 on center ^a	Scatterer No. 2 +1.5738 mm	Scatterer No. 2 -1.5748 mm
Cu (832 eV)	25.6%	25%	26.1%
Ni (852 eV)	17.3%	16.5%	17.8%
	Scatterer No. 3 on center	Scatterer No. 3 +1.5748 mm	Scatterer No. 3 -1.5748 mm
Cu (932 eV)	30.2%	30.4%	27.9%
Ni (852 eV)	21%	21.2%	19.4%

^aThe first point is in the center of the foil and the other two are 1.5748 mm to each side of the center.

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