MLM-2413(OP)

CONF-761210--4

β-BACKSCATTER MEASUREMENT OF THIN-GOLD COATINGS

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The topic of this treatise is a straightforward approach to problem-solving in nondestructive evaluation (NDE). Problems frequently come to NDE Groups through the management of other inspection areas. These problems can involve the conventional gaging and measuring techniques which are familiar to most design and production engineers and which, frequently, are time consuming and costly. Today, with modern instrumentation, dimensional inspection time can often be reduced by applying NDE methods.

Problem areas that respond to NDE methods are usually inspections which are time consuming, and in which conventional measuring methods have high intrinsic errors. An example of this type of problem involves a ceramic component, the MC2389. The substrate is a slim loop ferroelectric ceramic of high lead content with a gold coating (Figure 1). The coating procedure involves sputtering 300 Å of chromium, followed by 300 Å of a codeposit of chromium and gold, then 8000 Å to 16,000 Å of gold. The current method of measuring the gold thickness requires plating a glass sample slide along with the ceramic parts, then measuring the thickness of gold on the glass

*Mound Laboratory is operated by Monsanto Research Corporation for the U.S. Energy Research and Development Administration under Contract No. EY-76-C-04-0053.

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slide. The glass slide is used because of the high surface roughness of the ceramic (Figure 2). The measurement, done with a Tally-Surf profilometer, requires three hours per sample and is done off-line.

The NDE method determined to best fit the test requirements was β-backscatter. This test method requires approximately 10 minutes per sample and is done on-line. Measuring the thickness of β-backscatter coating is based on the principle of elastic recoil of β-particles by a coating-substrate system (Figure 3). When β-particles impinge on the sample, some recoil at approximately 180° and are detected by a Geiger Meuller tube. The thickness of the coating determines the number of recoiled β-particles detected and registered by the Geiger Meuller tube and counting circuitry. The glass slide is still required in this instance because the difference in atomic number between the gold coating and the ceramic substrate is insufficient to provide good counting statistics for coating differentiation.

Standards of suitable thickness sputtered on optical flats are required. The technician measures the high and low standards, the bare glass (for a background reading), and then the sample. Background is subtracted and the count data is plotted against log thickness on log-linear graph paper. The result is a straight line on which the sample thickness corresponds to the count rate for the sample.

This measurement enables the operating personnel to evaluate immediately the coating thickness at the sputtering operation site. An implication of this development is that the sputtering process can now be evaluated. The ceramics are coated 24 at a time with one glass sample. They are arranged in a 5 x 5 array. Prior to β-backscatter measurement, the time involved in measuring the thickness limited measurements to cases where the glass sample thickness alone was measured to qualify a lot for acceptance. Little information was gained regarding the sputtering process capability. But β-backscatter measurement now allows the determination of thickness at many locations on a glass slide, so that variations on the slide itself and the time stability of the sputtering machine can be determined.

Other variables, such as parameters associated with the sputtering operation, can also be evaluated in terms of deposition rate and uniformity.

Below is a summary of Mound Laboratory activities as reported at the 20th WANTO Meeting.

<u>NDT Reorganization</u>

All of Nondestructive Testing (NDT), which includes the Nondestructive Evaluation, NDT Laboratory and Radiography Groups, were combined into a single section in Explosives Operations. Prior to 1976, NDT had been split into two departments. The reorganization is beneficial in that more efficient use can be made of equipment and expertise.

NDT Certification

Eleven employes involved in nondestructive evaluation were certified by Mound Laboratory under Level I and Level II criteria recommended by the American Society for Nondestructive Testing. In Radiography two people were certified as Level I radiographers and eight were certified as Level II radiographers. One employee was certified at Level II in ultrasonic inspection. Certification requires rigorous classroom training, a specified educational background, and extensive work experience. The certification is recognized throughout industry. Plans have been made to certify personnel in liquid penetrant inspection and neutron radiography in 1977.

Californium Multiplier Neutron Radiography Facility

Ground was broken in 1976 for construction of the Neutron Radiography Facility located in the Test Fire area. This new facility will increase the ability to generate neutrons by a factor of 600 over our existing capability. Neutrons are obtained from subcritical multiplication of ^{235}U by a ^{252}Cf source. The multiplication factor is approximately 28. Neutron radiography is used as an acceptance test for several detonator and timer components.

FIGURE 1 - Slim Loop Ferroelectric Plate With Gold Coating. (Scale is in Inches)

FIGURE 2 - Tally-Surf Trace Indicating Surface Roughness Equivalent to the Coating Thickness. (Scale: 1 div = 50 microinches)

FIGURE 3 - The elements and their Arrangement for β-Backscatter Measurement of a Coating Thickness.

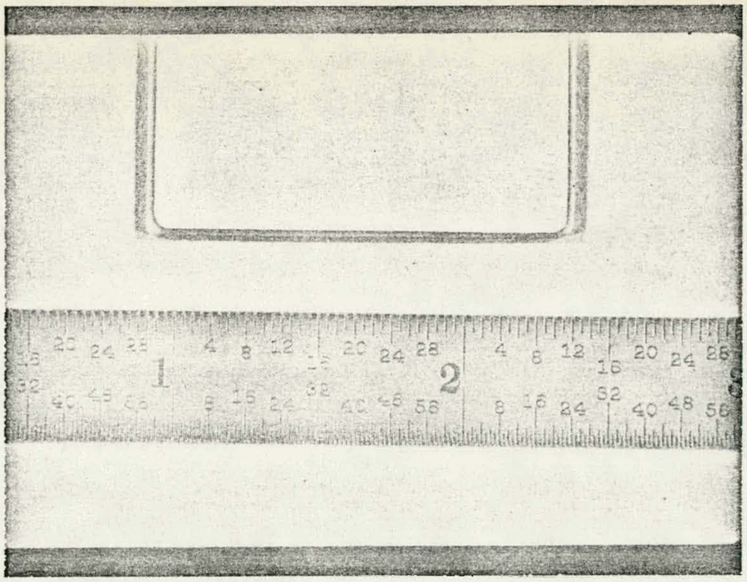

Fig 1

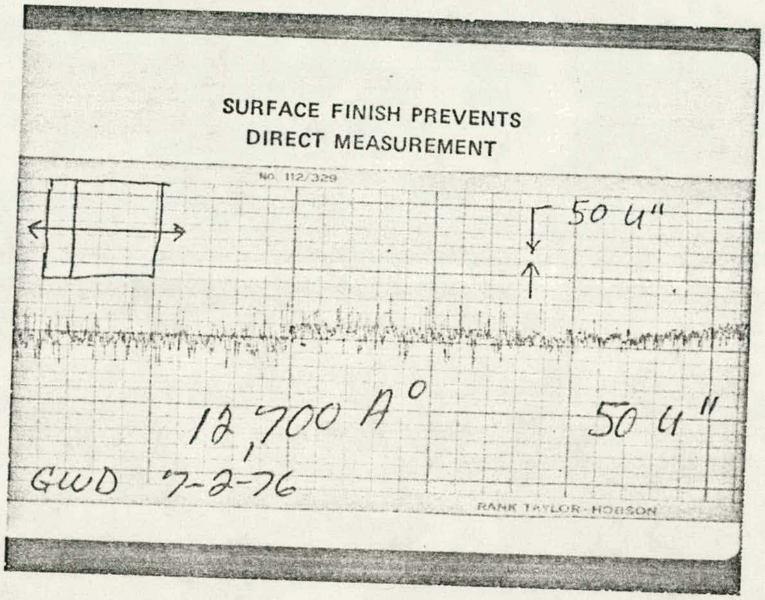

Fig 2

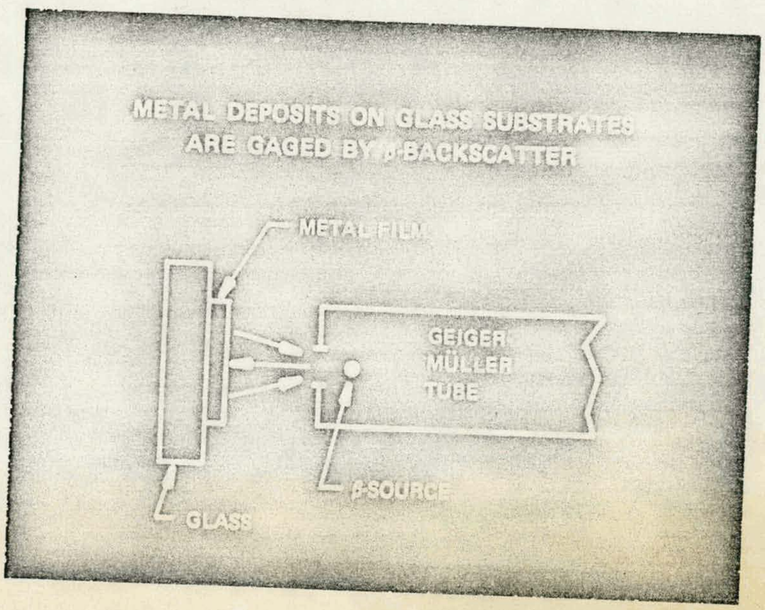

Fig 3