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PROPERTY EVALUATION OF PLUTONIUM SHEET USED IN CAPACITOR DISCHARGE STUDIES

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June 25, 1963

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TCG-WM-1 3-28-94

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June 25, 1963

PROPERTY EVALUATION OF PLUTONIUM SHEET USED IN  
CAPACITOR DISCHARGE STUDIES

INTRODUCTION

At the request of the Lawrence Radiation Laboratory, four plutonium strips 0.050 inches thick, 0.50 inches in width and 6 inches in length have been examined by metallographic, chemical, X-ray, density and dilatometric methods. The data obtained will help calibrate high energy electrical discharge equipment used to rapidly heat plutonium.

EXPERIMENTAL PROCEDURE

Figure 1 illustrates how the strips were sectioned and sampled for property determinations. Metallography samples were mounted in catalyzed Thalco polyester resin. Grinding and polishing was done on silicon carbide papers and syntron vibratory polishers. Electropolishing and electroetching was done in a solution of 20 parts tetraphosphoric acid, 30 parts water and 50 parts 2-ethoxyethanol. A sample from each strip was analyzed spectrochemically. The densities of the strips were determined using a fluid displacement technique. The X-ray diffraction patterns were obtained using a conventional North American Phillips X-ray spectrometer with a Geiger Mueller tube attachment. The expansion properties were determined using a quartz tube dilatometer with a L.V.D.T. transducer to indicate length changes. Figure 2 shows how the strips were supported in the vertical tube vacuum dilatometer.


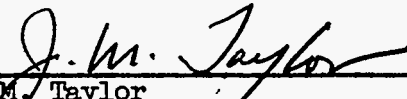
DISCUSSION AND RESULTS

Metallographic examination indicated that the strips had been cut from rolled sheet. The long axis (length) of the strip was perpendicular to the rolling direction. Microcracks or voids and inclusions were evident in the microstructure, Figures 3, 4, and 5. The inclusions were identified as being principally iron eutectic and nitrides. The small black elongated inclusions are the iron eutectic. The larger more equiaxed inclusions are nitrides. A typical grain structure is illustrated in Figure 6. The strips had an extremely small grain size.

The strips were of moderate purity as indicated by the chemical analyses and density data, Table I. The principal contaminants being Fe, Cr, Ni and C. X-ray diffraction patterns showed only alpha phase.

The expansion properties were measured perpendicular to the rolling direction. Expansion curves of two specimens from different strips are shown in Figure 7 and are essentially the same. Table II contains the average coefficients of expansion over the 100 degree temperature range. Essentially no effect of rolling upon expansion coefficient was observed.

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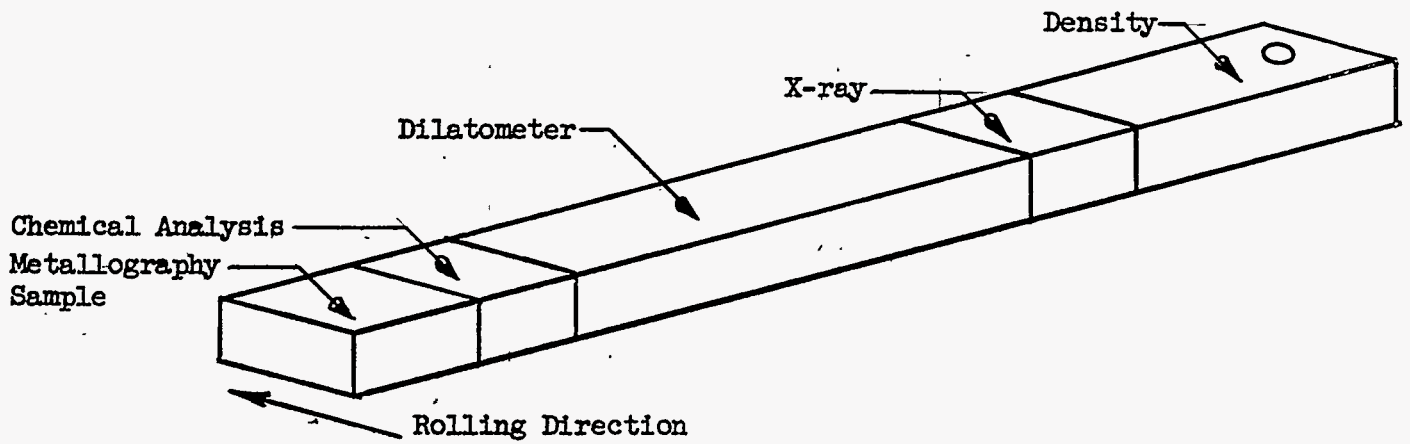


Figure 1

SAMPLING PROCEDURE FOR PLUTONIUM CAPACITOR DISCHARGE STRIPS



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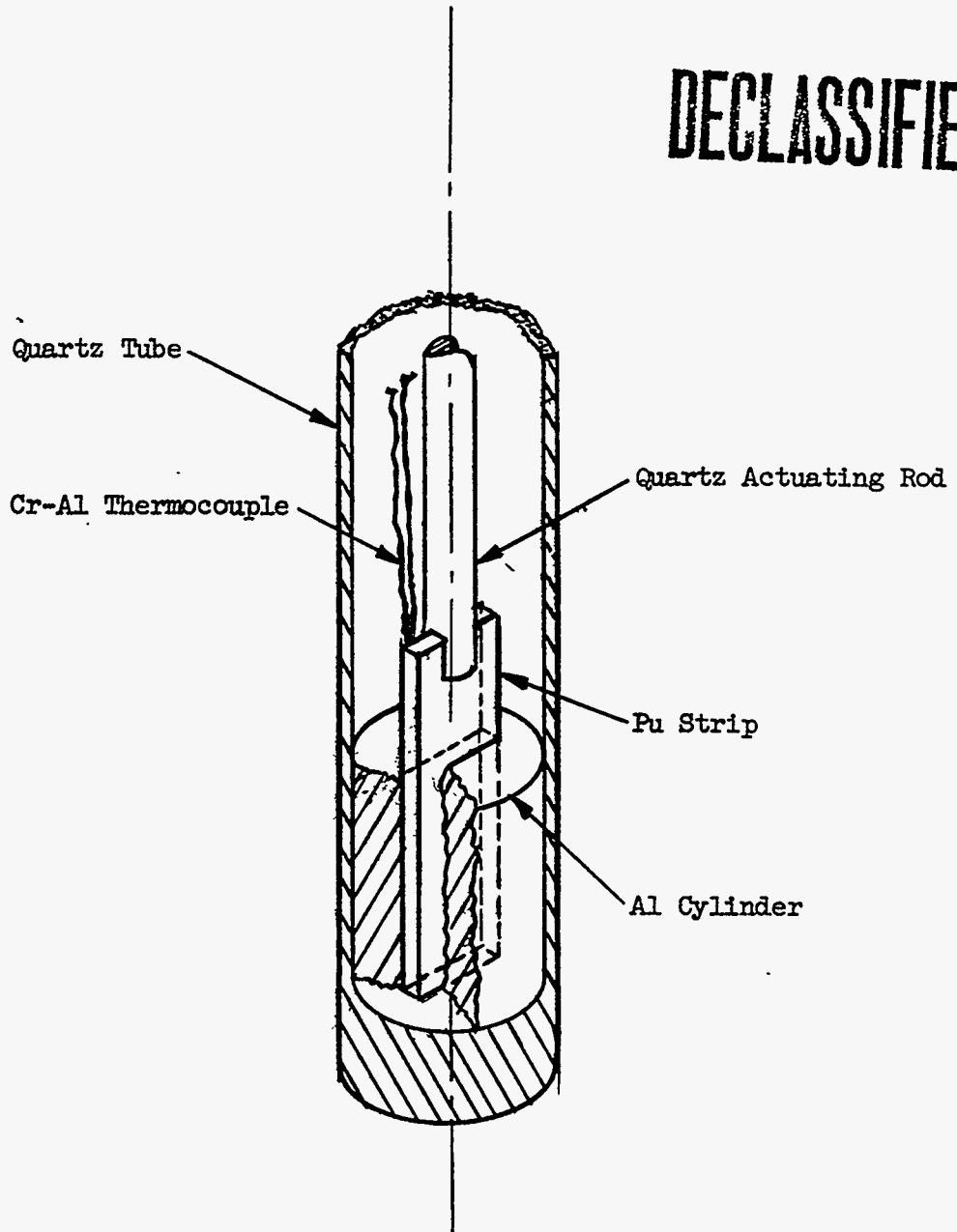


Figure 2

DILATOMETER SUPPORT ASSEMBLY FOR MEASURING  
EXPANSION OF PLUTONIUM STRIPS



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Microcrack or void in plutonium strip. Rolling Direction ↑ . As-polished. 150 X.

Figure 3

Pu<sub>6</sub>Fe eutectic and nitride inclusions (at top of photo micrograph) in plutonium strips. Rolling direction → . Electro-etched for 2 sec., bright field. 250 X.

Figure 4



Nitride inclusions in plutonium strips. Photograph of area across width of strip. Electro-etched for 2 sec., bright field. 250 X.

Figure 5



Electro-polished plutonium strip. Polarized illumination. 150 X. Grain size, approx. 0.007 mm.

Figure 6

TABLE I  
SPECTRO-CHEMICAL ANALYSIS AND DENSITY DATA OF PLUTONIUM STRIPS  
8-03-C-1344, 8-01-C-1344, 8-10-C-1344, and 8-05-C-1344

01			03			05			10		
Element	ppm	Density g/cc	Element	ppm	Density g/cc	Element	ppm	Density g/cc	Element	ppm	Density g/cc
Ag	L1	19.49	Ag	20	19.46	Ag		19.44	Ag		19.49
Al	20		Al	15		Al			Al		
Bi	-		Bi	-		Bi	-		Bi	15	
Ca	15		Ca	15		Ca	15		Ca	15	
Cr	200		Cr	500		Cr	200		Cr	250	
Cu	50		Cu	50		Cu	50		Cu	50	
Fe	620		Fe	490		Fe	662		Fe	905	
Mg	50		Mg	50		Mg	10		Mg	25	
Mo	1		Mo	1		Mo	-		Mo	5	
Mn	50		Mn	50		Mn	50		Mn	25	
Na	20		Na	50		Na	20		Na	50	
Ni	200		Ni	500		Ni	200		Ni	500	
Pb	10		Pb	10		Pb	20		Pb	5	
Si	20		Si	20		Si	20		Si	50	
Sn	2		Sn	2		Sn	2		Sn	10	
C	535		C	305		C	220		C	420	

L = Less than

TABLE II  
AVERAGE COEFFICIENTS OF EXPANSION OF PLUTONIUM STRIPS FROM  
20 - 100°C

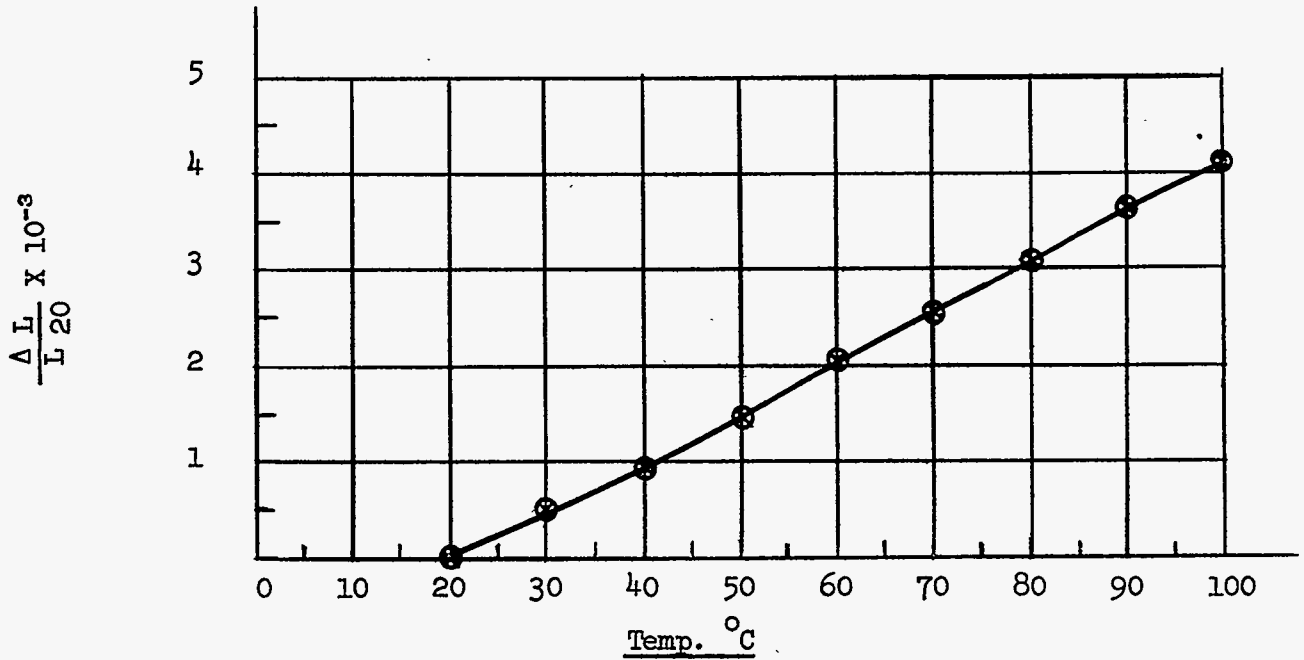
<u>Temperature Range °C</u>	<u>Coeff. of Expansion X10<sup>-6</sup> °C<sup>-1</sup></u>
20 - 30	48
20 - 40	48
20 - 50	50
20 - 60	51
20 - 70	51
20 - 80	52
20 - 90	53
20 - 100	52

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Figure 7  
EXPANSION CURVE OF ALPHA PLUTONIUM  
CAPACITOR DISCHARGE SLABS



○ Slab 8-05-C-1344  
X Slab 8-03-C-1344  
I<sub>20</sub> 1.249

