18. Dielectric Measurements of Solids at Microwave Frequencies

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The method for measuring the dielectric constant ε' and loss ε'' of solids at microwave frequencies was reported.

The experimental equipment that operates at the wavelength range of 8~12 cm was consisted of waveguide components (75mm×40mm I.D.) which were coax-waveguide transition, attenuator, standing wave detector and dielectric cell, and all these components were silver-plated.

As the microwave generator a reentrant cavity oscillator using a light house tube, type 2C40, was employed and the output signal was fed to the coax-waveguide transition by a coaxial cable. The operation of this oscillator was found to be satisfactory in the frequency stability and the output power for the present purpose.

The dielectric sample was inserted in the dielectric cell, a section of waveguide, and terminated by a reflecting plane. The dielectric properties of the sample were calculated from the observed standing wave ratio, ρ, and the location of the voltage minimum point for a short-circuit and a open-circuit termination by the equation (W.H. Suaber Jr. J. App. Phys. **19** 1130 (1948))

$$\frac{\varepsilon'-(\lambda/\lambda_c)^2-j\varepsilon''}{1-(\lambda/\lambda_c)^2}=\left(\frac{\rho_{sc}+j\tan\theta_{sc}}{1+j\rho_{sc}\tan\theta_{sc}}\right)\left(\frac{\rho_{oc}+j\tan\theta_{oc}}{1+j\rho_{oc}\tan\theta_{oc}}\right)$$

where θ is the angular shift of the minimum point when the dielectric cell replaced by a short circuit and the subscriptions, sc and oc, correspond to short and open circuit.

Particularly, measurements of voltage standing wave ratio, ρ, were carefully carried out by several methods because the accurate value of ρ was necessary for loss measurements.

The data obtained at $\lambda=8.08$ cm are given in the following table.

	ε'	tan δ
Cetyl alcohol	2.94	0.029
Bakelite (laminated)	4.01	0.032
Polymethyl methacrylate	2.53	0.008
Paraffin	2.27	——
10% Graphite in Paraffin	5.17	0.263
20% 〃 〃	8.14	0.493
10% Aluminum in Paraffin	4.98	0.091
20% 〃 〃	8.37	0.191

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19. Physico-Chemical Properties of W Metal Powder

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The structure of W metal powder obtained from the oxide by H_2 reduction is complex. In report I (N. Sasaki, R. Ueda: Science of Powder. 3. (1949) 1) a viewpoint was proposed for the clearer understanding of the structure, namery, the ultimate unit is W single crystals of various shapes ranging from about 0.5μ to 0.1μ. These "primary particles" partly exist as such, but are largely found as aggregate with some solidity. These "secondary particles" in their turn are partly found in loosely connected "tertiary particles" and so on.

The present paper is concerned with the effect of the pressing on the structure of powder produced from two different sorts of oxide, the one being oxide obtained by the decomposition of sodium tungstate with hydrochloric acid, the other by roasting ammonium-paratungstate. The redncton was carried out by continuouly elevating the temperature from 500 to 800°C in about one hour. The powder was pressed to a briquette under hydraulic pressure of 11 tons per square inch. In water the briquette disintegrated at once and on slight stirring dispersed to fine particles. With the dried powder and the original powder following measurements were made: a) the specific gravity calculated from the sedimentation volume; b) the surface area per gram by B.E.T. method and the mean particle diameter calculated therefrom; c) the particle size distribution by Wiegner; and d) electron microscopic observations.

The results are shown in accompanying table.

W powder from	pressing	sp. grav.	Surface area per gram	mean dia from B.E.T.	particles size distribution	
					Wiegner method μ	elect. microscope μ
WO_3	before	4.0	0.651m²/g	0.476	1.5~3.5	0.2~2
	after	7.5	0.658 〃	0.473	0.5~1.5	0.2~2
amm. para-tungstate	before	4.0	0..25 〃	0.497	3~14	0.5~3
	after	9.1	0.631 〃	0.492	0.5~3	0.3~3

From that results we see that

1) The pressing greatly reduced the particle size of the original powder (the