Dielectric Constants of $PbMoO_4$ and $CaMoO_4$*

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The dielectric constants ϵ' of $PbMoO_4$ and $CaMoO_4$ were measured at 24.5°C in air. Two specimens of each orientation were measured. The average values and the deviations for the measured dielectric constants are as follows: $PbMoO_4$: $\epsilon' \| a$, 34.0 ± 0.4; $\epsilon' \| c$, 40.6 ± 0.2; $CaMoO_4$: $\epsilon' \| a$, 24.0 ± 0.2; $\epsilon' \| c$, 20.0 ± 0.2.

WULFENITE ($PbMoO_4$) and powellite ($CaMoO_4$) both have the scheelite ($CaWO_4$) structure,[1] which is tetragonal with the space group C_{4h}^6-$I4_1/a$. This class of componds has been investigated as a host crystal for laser applications and it would be useful to know the dielectric constants for these materials, which to the authors' knowledge have not been determined.

Single crystals of the materials were grown by the Czochralski method. A spectrochemical analysis indicated that the following impurities were present: $PbMoO_4$: Sn, Sr 0.001–0.01%; Ag, Ca, Cu, Fe, Mg< 0.001%; $CaMoO_4$: Al, Cr, Si, Sr 0.001–0.01%; Ag, Ba, Cu, K, Li, Mg, Na, Pb<0.001%. The crystals were oriented by the Laue back-reflection x-ray method and samples were prepared in the form of disks with about 0.5 cm^2 area and 0.5 mm thick. To determine the permittivity tensor for the tetragonal scheelite structure it is necessary to measure only the dielectric constants in the a and c directions. The surfaces were polished and silver electrodes were applied by evaporation.

The capacitance measurements were made with the sample held between the plates of a parallel-plate capacitor. The two-terminal capacitance of the samples was measured by a substitution method. The experimental procedure is described by von Hippel.[2] All measurements were made at room temperature (24.5°C) in air. The dielectric constants obtained at 1.59 kc/sec are as follows:

Parallel to a axis	$PbMoO_4$	$CaMoO_4$
Dielectric constant ϵ'	34.0 ± 0.4	24.0 ± 0.2
Index of refraction[3]	2.28	1.984
Parallel to c axis		
Dielectric constant ϵ'	40.6 ± 0.2	20.0 ± 0.2
Index of refraction[3]	2.40	1.974

Two specimens of each orientation were measured; the table shows the average values for the specimens and the deviations for their measured dielectric constants. The dielectric loss ($\epsilon' \tan \delta$) for both orientations of the $PbMoO_4$ specimens was of the order of 10^{-2} or less; for the $CaMoO_4$ specimens, 10^{-3} or less.

The anisotropy of the dielectric constant (ϵ') is appreciable, but probably the most interesting observation is the inversion of anisotropy which is consistent with the optical observations. A similar inversion in the anisotropy of the dielectric constant was observed when comparing corundum-structure compounds Al_2O_3 and Cr_2O_3.[4] In this case Cr_2O_3 is similar to $PbMoO_4$ and Al_2O_3 is similar to $CaMoO_4$. The dominant effect of the cation on dielectric anisotropy could be an interesting subject for theoretical investigation.

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[1] A. N. Winchell and H. Winchell, *Microscopical Characteristics of Artificial Inorganic Solid Substances* (Academic Press Inc., New York, 1964).

[2] A. R. von Hippel, *Dielectric Materials and Applications* (John Wiley & Sons, Inc., New York, 1954).

[3] E. S. Larsen and H. Berman, U. S. Geol. Surv. Bull. **848**, 74, 94 (1934).

[4] P. H. Fang and W. S. Brower, Phys. Rev. **129**, 1561 (1963).