beryllium inside the cyclotron chamber, the volume of powder usable is limited, but the solid angle subtended by it at the neutron source is considerably increased (to about 8 percent of 4π).

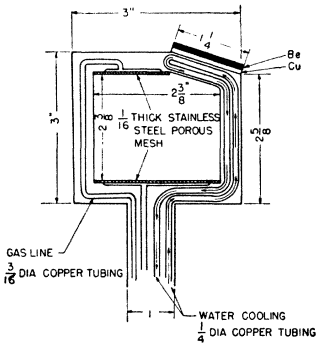

FIG. 1. Schematic diagram of probe for production of He^6.

To this end, a hollow chamber (Fig. 1) was designed, of approximate dimensions 3 in.×3 in.×1½ in. It was constructed from a copper block and soldered onto a 1-in. brass pipe so as to fit through the lock into the cyclotron chamber. The beryllium metal powder was of extremely fine grain size (of the order of 1 micron); it is held in place by two porous stainless steel screens, which are soldered to frames inside the chamber.

To produce neutrons from the deuteron beam of the cyclotron, a press-fitted Be-Cu plate was soldered onto the probe at an angle, with the Be face out. Helium gas was used as a carrier, and was circulated continuously through the probe.

Because of the short lifetime of He^6, the counting circuits were operated automatically by a series of relays in connection with a motor driven cam-shaft. This apparatus turned the cyclotron on for about 2.5 sec.; ¼ sec. after the cyclotron was turned off, the monitor and spectrometer counters were turned on for a period of 2 sec.; after another ¼-sec. time interval the entire cycle was repeated.

The active gas was pumped into a source chamber which was separated from the spectrometer chamber of a semicircular focusing magnetic spectrometer by a Saran window. The monitor determined the amount of activity in the chamber; by subtracting backgrounds and taking the ratio of the spectrometer counter reading to monitor counter reading the He^6 spectrum was obtained. The window thickness was about 1.8 mg/cm² and the thickness of the gaseous source about 0.1 mg/cm².

Because of the comparatively low intensity obtained, wide slits were used and the resolution of the spectrometer was about 6 percent. One of the spectra so obtained, plotted in a Fermi plot, and without correcting for resolution or window absorption, is shown in Fig. 2. The tailing off at the high energy end is due to the poor resolution. The end point, obtained from an average of such plots following subtraction of the energy loss (~5 kev) in the source window near the end point, is $E_0=7.30$ mc², corresponding to a maximum energy of (3.215±0.015) Mev. Furthermore, the spectrum seems to be allowed at least down to 200 kev, which corresponds to a range of 95 percent of the spectrum. Using Holmes' value of the half-life, one obtains a value of ft for He^6 of 570±3 percent, which is the smallest value known. Both the low ft value and the allowed shape of the spectrum tend to confirm the Gamow-Teller selection rules, assuming that He^6 has a spin of zero.

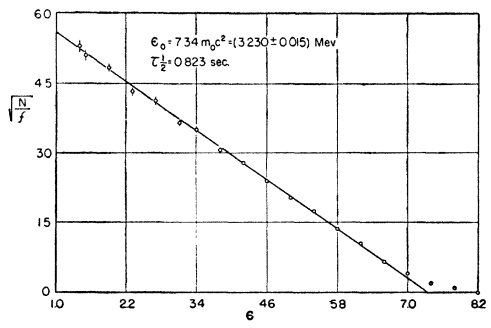

FIG. 2. Fermi plot of the He^6 beta-spectrum, uncorrected for resolution and window absorption. E is the total energy in units of mc². f is the Fermi function $\eta^2F(Z, E)$, N the number of electrons per unit momentum range. $(N/f)^{\frac{1}{2}}$ is plotted in arbitrary units. The value given for $\tau_{\frac{1}{2}}$ is that of Holmes.

We wish to thank the U. S. AEC, which aided materially in the performance of this research.

* Assisted by the AEC.

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An Anomalous Dielectric Effect of Vacuum-Sputtered CaF_2 Layers

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ASSUMING that crystal defects have an influence on dielectric properties of ionic crystals, I have investigated the properties of vacuum-sputtered layers of CaF_2. It is well known that just after sputtering, the layers are composed of small separate crystals which slowly change into a compact crystalline layer. In my experiments I observed an anomalous effect which is perhaps to be interpreted as a result of the crystal defects, but which is greater than expected. The experiments indicate that just after sputtering, the effective dielectric constant ϵ of the fluorspar was of the order 150–6000. In a few hours or days the dielectric constant diminished to a value of the normal magnitude of 7–10. Simultaneously the resistance of the layer, which at first was relatively small, increased to a value corresponding to the conductivity of the normal crystalline CaF_2.

The layers were formed on a glass plate as a plate condenser as indicated in Fig. 1. The thickness of the CaF_2 layer was measured optically, and the capacitance of the plate condenser by a common a.c. bridge and from the discharge curve of the condenser. The a.c. resistance was estimated by loss-angle measurements. The d.c. resistance was measured with a Wheatstone bridge or estimated from the discharge curve. Some typical results are shown in Table I.

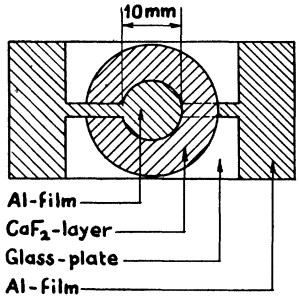

FIG. 1. Glass plate condenser.

TABLE I. Characteristics of CaF_2 layers.

Thickness A.u. (10^{-7} cm)	Time after sputtering	Capacitance μF	A.c. resistance $k\Omega$	D.c. resistance $k\Omega$	Dielectric constant
1000	0	5.0	1.25		550
	30 sec.	1.5	8.5		165
	5 min.	1.2	14.5		130
	24 hr.	1.1	18.0	>1000	120
	48 hr.	0.22			24
3000	0	3.0	1.75		990
	10 min.	2.7	2.45		895
	2 hr.	1.7	3.10	100	560
	18 hr.	0.03	175	>1000	9.9
	14 day	0.03	200		9.9
10000	0	4.0	1.35		4400
	1 min.	2.4	2.20		2600
	5 min.	2.0	2.90	70	2200
	15 hr.	0.017	310	700	19
	7 day	0.005	>1000	>1000	5.5

In ten such condensers examined the thickness of the CaF_2 layer varied between 1000 and 20000 angstrom units. The precision of the measurements is too small to draw any definite conclusions. It seems, however, that the evaluated dielectric constant increases with increasing thickness of the CaF_2 layer and probably approaches asymptotically a certain limiting value. It is also clearly seen that the a.c. resistance is considerably smaller than the d.c. resistance. This fact may be interpreted by a hesteresis phenomenon. Also the slope of the discharge curve makes this interpretation probable.

Finally it should be pointed out that a CaF_2 condenser several days or weeks old resumes the anomalous high capacitance when moistened by water.

The experimental work was carried out by Mr. E. Vesa. The investigation continues.

The Response of the Anthracene Scintillation Counter to Monoenergetic Electrons*

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December 12, 1949

IT has been determined previously that the light pulse produced by an electron striking a phosphor substance such as anthracene is approximately proportional to the energy of the impinging electron over limited ranges of energies.[1,2] One desires to know how the pulse height for monoenergetic electrons varies with energy from an energy of a few kev up to an energy of several Mev.

A 180 cm single-lens β-ray spectrometer with an aperture of approximately 0.3 cm was used to supply the monoenergetic electrons. It was equipped with a sliding baffle so that the γ-ray and external background could be determined and the correction of counts made at each pulse height setting. Approximately 50 microcuries of Cs^{137} evaporated on to a thin Formvar film served as a source of electrons. The energy of the conversion electrons (630 kev) was used to determine the spectrometer constant. The end plate of the spectrometer at the counter end was made of soft iron and had at its center a mica window having $\frac{3}{8}$ inch diameter and 1 mg/cm² thickness. An anthracene crystal 1.3 cm in thickness was attached with Canada balsam to the photosensitive area of an RCA-5819 photo-multiplier tube. The crystal was then covered with a 0.2-mil light-reflecting aluminum foil and mounted directly in front of the window. A soft iron shield surrounding the scintillation counter, in conjunction with the end plate of the spectrometer, served to prevent variations in magnetic field in the region of the photo-multiplier tube.

The output from the photo-multiplier was fed into a preamplifier and linear amplifier[3] combination and counts recorded on a scaler. The output from a pulse generator was used to check the amplifier for linearity and to determine the zero of the pulse height dial.

Counts per second *versus* pulse height data were recorded for each chosen energy and the differential curves plotted to determine the pulse height giving the maximum number of counts per second. Some typical curves are shown in Fig. 1 where the counts per

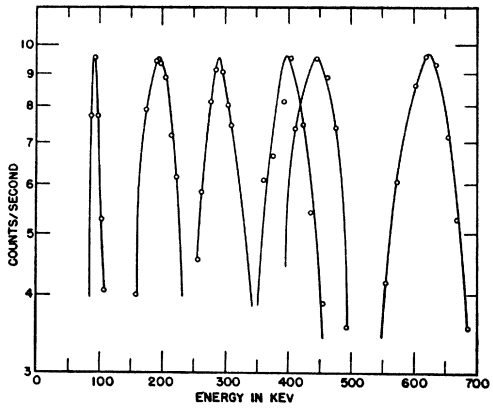

FIG. 1. Counting rate as a function of electron energy.

second have been normalized and plotted against the energy of the electrons in kev. These curves are within the expected statistical variation of the counts per second. It is estimated that the energy corresponding to a maximum number of counts per second for these curves is determined to an accuracy of ± 1.0 kev near 100 kev and to ± 4.0 kev from 400 to 665 kev.

In Fig. 2 is shown the pulse height variation with energy. It is noted that there is a slight deviation from linearity below 125 kev. Absorption data for electrons given by Glendenin[4] were used to

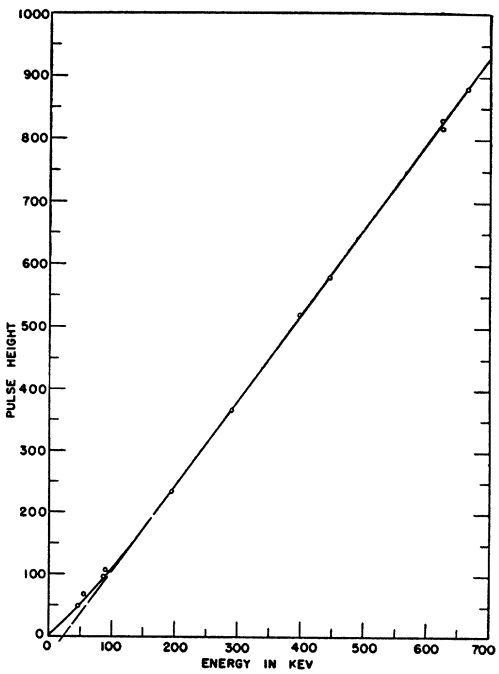

FIG. 2. Pulse height as a function of electron energy.