

SOLID STATE NEWS

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THE COMMON DENOMINATOR

This publication has been prepared to serve a two-fold purpose. First, it will record history. It will record the adventures of the true pioneer of this modern age — the Scientist. The annals of the known are but the portals to the unknown. Secondly, this periodical will emphasize that the adventure of scientific discovery is not relegated to the elaborate palaces of research; chrome and glass alone cannot create. Man's creativity is as powerful in an attic as in a palace.

Historically, man's interest has shifted to progressively smaller units of matter. The Scientist's desire to discover the "common denominator" is the stimulus. The magnitude of this "new world" is difficult to comprehend and even more difficult to describe. Solid State Physics has taken upon itself this task. The Solid State Research Institute is proud to partake in the "great exploration". The Solid State News is the Institute's way of thanking all those Scientists who are applying their creativity and skills to this exacting task.

FRENCH RESEARCH REPORTS

by Yves Rocard

Yves Rocard is a Consultant to the Solid State Research Institute and the Director of the Solid State Research Institute in France. He is Director of the Physics Department of the Ecole Normale Supérieure. He is also Director of research for the French Navy on their infrared, guided missiles and image converter programs. He was decorated Commander of the British Empire for his work with the R.A.F. and has the rank of Admiral in the French Navy.

Pierre Venier working at the Physics Laboratory of Astronomy of the "Observatoire de Paris" published an article in the "Journal de Physique" 14,175, (1953) on the absorption of thin layers of lead sulfide in the far infrared. This work was done in relation to the photo-conducting properties of the material.

The results were at variance with other published work in the field. The author suggests that the propagation of light through thin layers of lead sulfide is complicated by a multiple reflection interference phenomenon which had not been thought of before and which can modify the transmitted light, independently of all absorption. If the necessary corrections are made to take into consideration the effects of these interferences, a net correlation is found between the existence of a determined photoconductivity to a given wave length and that of an optical absorption for this same wave length.

The determination of the infrared spectra of proteins in solution often gives trouble due to the masking of the protein lines by water absorption lines. Professor H. Lenormant of the Paris "Faculte des Sciences" has determined the infrared spectra of proteins in heavy water. The masking spectra are then displaced by the deuterium atom over the position of the hydrogen atom. In this way many protein infrared spectra have been satisfactorily determined.

SOLID STATE TOPICS

Tadao Fukuroi, Seiichi Tanuma, and Shotaro Tobisawa. Science Repts. Research Insts., Tohoku Univ., Ser. A., 4 283097 (1952)

The resistivity and thermoelectric power of tellurium crystals containing 0.002 to 5 percent antimony were studied from -190 to 300°C . The Hall coefficients were also determined at -150° and at room temperature. The samples were prepared by using vacuum distilled tellurium and pure pulverized antimony. The mixture was put into a glass tube, degassed at $180-200^{\circ}$ and 10^{-5} mm mercury pressure. The tubes were then sealed off, smelted at 550° for one hour and remelted under hydrogen. The alloy was then sucked up into a hard-glass capillary and solidified slowly from the top by cooling in a furnace. The rods, which were about 2.5 mm in diameter and 6-9 cm long, were either single crystals or polycrystalline with many parallel crystallites.

The resistivity and Hall coefficient of the low antimony samples showed the characteristics of the intrinsic conductance at high temperatures but the resistivity decreased to 4.2×10^{-1} , 1.7×10^{-3} ohm-cm at room temperature. The resistivity was from 2.4 to 8.2×10^{-4} ohm-cm at liquid-air temperature. The Hall coefficient changed from -3.6×10^3 to $+3.3$ electromagnetic units at room temperature and from 3.9×10^4 to $+2.7$ at liquid-air temperature as the antimony content increased to 5.2 percent. The Hall coefficient of alloys containing more than one percent of antimony increased with rising temperature.

The thermoelectric power showed a change from positive to negative and back to positive with temperature increase for pure tellurium but the negative region showed a minimum positive voltage at intermediate temperatures with small antimony addition. It increased with temperature for higher antimony amounts.

Hideo Tazaki and Shigeya Kuwabara. J. Sci. Hiroshima Univ., Ser. A, 14, 251-4 (1950) In English

Electron diffraction studies were made to determine the reaction at 70-250°C between copper plates and sulfur vapor. At low sulfur concentrations, Cu_2S was formed but at high sulfur concentrations CuS was formed. At about 150°C, the 110 plates of copper were oriented parallel to the copper surface. A new diffraction pattern was obtained and was tentatively assigned to $\text{Cu}_{1.9}\text{S}$.

S. C. Jain and K. S. Krishnan. National Phys. Lab. India, New Delhi, Proc. Roy. Soc. (London) A215 431-7 (1953)

Results of the thermionic constants of metals and semiconductors are reported for Ti, Cr, Mn, Fe, Co, and Ni. The saturation vapor pressure of the electron gas in equilibrium with the metals was determined at various temperatures in a chamber formed of the metal. The pressure was determined by finding the rate of effusion of the electrons from the chamber into a vacuum through a small hole in a thin wall of the chamber. The chamber was formed by coating graphite with the metal to be studied.

E. G. Roka, C. H. Jackson, and R. P. Ulrich. Minneapolis-Honeywell Regulator Company, Minneapolis, Minnesota. J. Appl. Phys. 24, 228-9 (1953)

Point contact germanium rectifiers were prepared by covering the germanium surface with an insulating layer, punching a 1 mil hole in the insulator, and evaporating on a Ag contact.

Kazuji Hashimoto. Proc. Phys. Soc. Japan 7,276-83 (1952)

Preparation of single crystals of CdS, photoconductance of CdS on irradiation with light and x-rays, mechanism of photoconductance, and its application to x-ray engineering are reviewed.

T. R. Ellickson. (University of Oregon, Eugene.) *J. Opt. Soc. Amer.* **43,196-7 (1952)**

In a study of the electron trapping states in phosphorus, the energy gap in polar crystals were found to decrease with temperature by about .005 electron volts per degree. One effect of this change is that phosphorescent decay measurements at different temperatures give indicated oscillation frequencies for trapped electrons which are too high by a factor of the order of 100. Since these apparent frequencies are already several orders of magnitude less than crystal oscillation frequencies, the indications are that the electron frequencies are not closely connected with crystal oscillation frequencies. The variation of energy gap with temperature may account for the few cases where thermal activation energies are larger than optical activation energies.



Simon Larach, *J. Chem. Physics* **21,756 (1953)**

A study was made of zinc selenide phosphors to determine the effect of additives and to compare the chloride and trivalent cation fluxes on the catholuminescence emission.

The phosphors were made by mixing 0.01 percent of metallic nitrate activators to ultra pure zinc selenide. If chloride were used, this was done by adding 2 percent of ammonium chloride. The mixtures were fused in a nitrogen atmosphere at 900°C and cooled in nitrogen. The additives were Cu, Mn, Ag, Al, Cu and Al, Ga, Cu and Ga and Pb. A cathode-ray tube with an automatic recording spectroradiometer was used to determine the emission intensity at various wave lengths.

In all cases the addition of chloride gave phosphors with higher emission intensity. The other significant results were 1. With no added activators, both chloride and aluminum gave phosphors with peak wavelengths shorter than the pure phosphors with no addition; 2. Addition of chloride, aluminum or gallium ions to zinc selenide phosphors activated with copper gave products with peak wave-lengths at 6470 Å; 3. A zinc selenide-chloride phosphor showed an increase in host-crystal emission intensity but aluminum had no effect and gallium acted as a poison; 4. Gallium interrupted the emission from a zinc selenide-copper phosphor.



P. D. Zemary, *Analytical Chemistry* **24,348 (1952)**

A thermistor was used to measure the temperature in a cryoscopic cell for 2ml. sample. The freezing point can be determined to -0.004 from 25° to -60°. The apparatus was part of a vacuum system for the determination of impurities in pentaborane.



RESEARCH ON POINT-CONTACT FIELD-CONTROLLED SEMI-CONDUCTOR DEVICES. THIRD INTERIM ENGINEERING REPORT, PERIOD DEC. 11, 1951-MARCH 11, 1952, UNDER CONTRACT NUMBER AF33(308)-23704, by R. C. Sirrine, D. C. Reynolds, C. S. Peet, and

A. E. Middleton. Battelle Memorial Institute, Columbus, Ohio. March 1952. 41 pages, graphs, tables, Available from Library of Congress, Photoduplication Section, Washington 25, D. C.

This report represents the experimental work performed to date towards developing a practical fieldistor. The first half of the report discusses the work done towards producing germanium of the desired purity. Two different approaches are used for producing pure germanium. One method consists of the thermal decomposition of germanium hydride. The other approach is the usual hydrogen reduction of GeO_2 followed by appropriate purification steps.

INFRARED TOPICS

NEW INFRARED DETECTOR BULLETIN

The Standard Transistor Corporation, a subsidiary of The Standard Piezo Co. has recently issued its new infrared detector cell Bulletin No. IR553. This publication contains complete technical and operating data, including curves and circuitry, for evaporated lead sulfide, chemically precipitated lead sulfide, lead telluride, and lead selenide infrared detector cells. Price lists and copies of the above bulletin are available upon request to The Standard Transistor Corporation, 155 East 44th Street, New York 17, New York.

INFRARED TRANSMITTING FILTERS

INTERIM REPORTS UNDER ENGINEERING RESEARCH AND DEVELOPMENT LABORATORIES CONTRACT NO. W-44-009-ENG-544. Polaroid Corp. Research Department, Cambridge, Mass. Photostats or microfilms of the following interim reports are available from Library of Congress, Photoduplication Section, Washington 25, D. C.

Interim Report PB 107025

Microfilm \$2.00

Photostat \$3.75

The use of high polymers for base materials for the formation of absorbing units *in situ* offers good possibilities for the construction of improved filters possessing high temperature stability, substantial opacity to visible light, and selective filtering action in the infrared. Dehydrated polyvinyl alcohol has excellent spectral characteristics for a band pass filter transmitting the 1-3 micron region, but improvement must be made in its mechanical properties. Dehydrohalogenated polyvinylidene chloride has given preliminary results of promise for the preparation of an improved filter material having high optical density in the visible, high thermal stability, good mechanical properties, and displaying selective transmission in the infrared beyond *ca.* 1.

Interim Report PB107026Microfilm \$2.25
Photostat \$5.00

Discussion of investigational work on absorber-type filters, powder filters, supporting materials and instruments for rapid inspection of filter material and comparative values of energy transmitted at various wave lengths.

Interim Report PB 107027Microfilm \$2.25
Photostat \$5.00

Discussion of powder filters, C-sheet-powder filters, C-sheet preparation, C-sheet-glass lamination and instrumentation.

Interim Report PB 107029Microfilm \$1.75
Photostat \$2.50

Discussion of C-sheet filters, Christiansen filters and the elimination reactions in polymers.

Interim Report PB 107030Microfilm \$1.75
Photostat \$2.50

Discussion of C-sheet filters, powder C-sheet filters and polymonochlorotrifluoroethylene and polytetrafluoroethylene filters.

Interim Report PB 107031Microfilm \$2.00
Photostat \$3.75

Discusses the work on the preparation and properties of this two-layer band-pass filter for wave lengths of 3 to 6 mm.

Interim Report PB 107032Microfilm \$2.00
Photostat \$3.75

A survey of the infrared transmission of scattering layers made by milling particles of metallic oxides of high refractive index into a silver chloride begins to show some regularities. Some oxides actually studied have relatively wide pass bands. (Fe_2O_3 , Cr_2O_3 , and Mn_xO_y). Others have narrower pass bands which are either symmetrical on a linear wavelength scale (TiO_2 and NiO), or unsymmetrical so as to give a sharper cut on the longer wavelength side (CuO and Co_xO_y). These narrower bands are presumably Christiansen bands. It appears that metal oxide particles in silver chloride might afford practical band pass filters in the 6 to 15 microns range of wavelengths and higher and that other scattering filters will be necessary for the 1 to 6 microns range.

Interim Report PB 107033

Microfilm \$1.75
 Photostat \$2.50

We have completed a survey of silver chloride scattering layers and have begun a survey of similar layers made by milling various metallic oxides into polytetrafluoroethylene (Teflon). We include the infrared transmission curves of the resulting scattering filters over the region 1 to 15 microns. Simple and complex oxides of metals in the range ${}^3\text{Li}$ to ${}^{14}\text{Si}$ exhibit Christiansen transmission peaks in the range 4.5 to 6 microns while oxides in the range ${}^{22}\text{Ti}$ to ${}^{30}\text{Zn}$ show either no interesting peaks, or peaks on the long wavelength side of the strong Teflon absorption at 8.4 microns. In none of these scattering layers are sharp high-pass cutoffs found by the methods employed.

Interim Report PB 107034

Microfilm \$2.00
 Photostat \$3.75

Contains paper entitled "Comparison of the performance of the Polaroid XRN infrared filters with the performance of ideal filters by R. Clark Jones." Appendix: Comparison of the performance of the Polaroid XRN infrared filters with the performance of ideal filters, by R. Clark Jones.

Interim Report PB 107035

Microfilm \$2.00
 Photostat \$3.75

1. Filters — Materials
2. Filters, Infrared
3. Infrared — Research.

Final Report PB 107036

Microfilm \$ 3.75
 Photostat \$11.25

1. Filters — Materials
2. Filters, Infrared
3. Infrared — Research.

OPTICAL PROPERTIES OF TELLURIUM IN THE INFRARED

T. S. Moss, Proc. Phys. Coc. 65, B, Jan. 1952 62-66

Tellurium films were produced by vacuum evaporation for study of optical properties. Refractive index determination was used for the range of 3-11 microns. The refractive index was found to be 4.8 microns. The absorption constants were determined by the transmission method for films from 0.26 to 3 microns in thickness. At 1 micron the absorption constant was $2 \times 10^5 \text{ cm}^{-1}$. The main part of the absorption band was between 0.6 and 1.0 micron. The measurements indicated their absorption edge between 3 and 3.5 microns which is approximately the 'threshold' wavelength of the photo-conductivity effect of this material.

STANDARD PIEZO COMPANY

New Developments

Standard Piezo Company, a subsidiary of Brown-Allen Chemicals, Inc., is primarily a manufacturer of quartz crystal units. The normal production requirements to satisfy civilian and military customers are furnished by three plants located in Carlisle, Pennsylvania.

These quartz crystal units are fabricated to close tolerances and when used in a properly designed oscillator, will control the frequency with an accuracy equal to or better than 50 ppm, over the wide temperature variation from -55°C to $+90^{\circ}\text{C}$. Complete testing over this temperature range and sampling for other strict requirements of vibration, shock and aging insure premium performance.

New developments extending the frequency range under quartz crystal control both to the lower and the higher frequencies are a continuing research problem. Higher frequency units employing third, fifth and higher mechanical overtone operation require special fabricating techniques. Techniques, peculiar to the optical industry, and their adaptation to the specific processes in the quartz crystal industry are under investigation. Initial investigations of these processes have yielded higher quality units than heretofore available. Extending the range of low frequency shear mode fundamental oscillator plates has been the goal for years. Standard Piezo is continuing research on this problem to satisfy the needs of military and civilian groups.

Application of quartz crystal units, other than those for frequency control, are investigated in the plant laboratory. Piezo electric-gauges, electro-mechanical transducers and any effects associated with Piezo electricity as applied to quartz are also investigated.

The laboratory furnishes information and guidance to those who require assistance in selecting the proper unit from the more than forty types manufactured. Standard Piezo Quartz Crystal Catalogs and general information about oscillator circuits are also available upon request from Standard Piezo Company, Carlisle, Pennsylvania.