A line emission penetration phosphor, suitable for use in high brightness CRT's, has been developed. The penetration phosphor powder particles consist of a coating of small red emitting YVO_4:Eu particles on the surface of larger core particles containing a nonluminescent surface layer of $La_2O_2SO_4$:Tb and a green emitting center of La_2O_2S:Tb. Optimization of this system with respect to brightness and color range has resulted in a material comparable to other high brightness penetration phosphors except for the exploitable advantage of being a narrow band emitter. The preparation, optimization, and cathodoluminescent properties of this system are discussed.

Abstract No. 158

A New Design of Voltage Penetration Phosphor

L. Li, Z. X. Zhang, and **S. H. Xu,** Changchun Institute of Physics, Changchun 130021, Jilin, China

A new design of a voltage penetration phosphor of the onion skin type is proposed and demonstrated by a material with its main composition $SrAl_2O_4$, of which the core is activated by Eu^{2+}, emitting in the blue-green region while the exterior is activated by Eu^{3+}, emitting red light under cathode ray excitation. It is prepared by first synthesizing $Sr_{0.90}Ca_{0.10}Ba_{0.05}(Al_{0.97}Ga_{0.03})_2O_4:Eu^{2+}_{0.05}$ in a reducing atmosphere and subsequently firing in air to oxidize Eu^{2+} ions in the outer part of the crystals to Eu^{3+}. The color change under different excitation voltages shows the feasibility of this technique.

Luminescence of II-VI Compounds

Abstract No. 159

Recent Advances in Electrical and Optical Properties of II-VI Compound Semiconductors

P. J. Dean, Royal Signals and Radar Establishment, Great Malvern, Worcestershire, WR14 3PS England

The II-VI semiconductors ZnSe, ZnS, and their alloys provide efficient luminescence throughout the visible spectrum and are very suitable for thin film CRT screens and various high-field EL devices made from powders, thin films, or single crystals. Recent renewal of interest in these materials springs from the need for active, thin panel displays, application of improved material preparation techniques and new insights into the control of their electrical and optical properties, long regarded as intractible.

Abstract No. 160

Properties of Low Resistivity N-Type ZnSe Prepared by Organometallic CVD

W. Stutius, Xerox Corporation, Palo Alto Research Centers, Palo Alto, CA 94304

Low resistivity n-type ZnSe has been grown epitaxially on (100) GaAs substrates by a low-pressure low-temperature organometallic CVD process. Aluminum is used as a dopant. The as-grown layers show a strong near-bandgap photoluminescence (PL) peak. The much weaker PL intensity at longer wavelength indicates that the concentration of deep centers is lower than in doped ZnSe prepared by other methods. The relationship between the electrical and the PL properties is discussed.

Abstract No. 161

Luminescence and EPR of Chloride-Doped ZnTe

N. Magnea, K. Saminadayar, D. Galland, J. L. Pautrat,* and **R. Triboulet,** CEN-G/DRF-Physique du Solide, 85 X, 38041 Grenoble, Cedex, France

The shallow hydrogenic donor related to chlorine has been identified from two electron transitions revealed by resonant and photoexcitation spectra. From the shift between 1S and 2P state we obtain $E_D^{Cl} = 20.1$ meV to be compared to $E_D = 18.3$ meV for the "native" donor commonly observed in ZnTe. On the same crystal, a photosensitive and isotropic EPR signal is detected with a well-resolved structure. The characteristics of this signal are $g = 1.964 \pm 0.001$, $A_{Cl^{35}} = 47\ 10^{-4}$ cm. Moreover the hyperfine interaction with Cl^{37} is also observed. All these results indicate that chlorine introduces simultaneously a shallow donor and a deep level in ZnTe, this latter level can be a substitutional Cl^- ion on a Te site.

Abstract No. 162

Photoluminescence Study of Shallow Acceptors in Refined Cadmium Telluride

E. Molva, J. P. Chamonal, and **J. L. Pautrat,*** CEN-G/DRF-Physique du Solide, 85 X, 38041 Grenoble, Cedex, France

We report on the first observation of "two hole" transitions in low temperature photoluminescence spectra of high purity p-type cadmium telluride. The undoped samples reveal two acceptors with binding energies of 108 and 149 meV. Li and Na incorporated by low temperature diffusion introduce hydrogenic acceptor levels at 58 and 59 meV. The accurate binding energies which are obtained are quite different from published data.

Abstract No. 163

Nitrogen as a Shallow Acceptor in ZnSe

B. J. Fitzpatrick* and **P. M. Harnack,** Philips Laboratories, Briarcliff Manor, NY 10549

Nitrogen should be a good acceptor in ZnSe, but no evidence of acceptor action due to nitrogen has been seen in as-grown material. Using epitaxial techniques, evidence of incorporation in a variety of ways has been obtained from photoluminescence and electrical measurements. In LPE material grown at normal temperatures (950°-800°), an exciton with a binding energy of 10.8 meV (typical for a shallow acceptor) has been observed. At higher temperatures, a band at ~2.73 eV is seen, which we believe is the donor-acceptor pair band of the nitrogen acceptor. This band has been seen in material grown from both the liquid and the vapor phase, using several doping sources (NH_3, Zn_3N_2, NH_4Br). We believe that these data indicate that nitrogen is a shallow acceptor with an ionization energy of ~85 meV.

Abstract No. 164

Impurity-to-Conduction Band Electron Transfer Transitions in ZnSe:Co

D. J. Robbins,* P. J. Dean, and **C. West,** Royal Signals & Radar Establishment, Malvern, Worcestershire, WR14 3PS, England

Three weakly-phonon-coupled absorption bands have recently been reported (1) for $ZnSe:Co^{2+}$, together with several associated luminescence transitions. This paper will report Zeeman and uniaxial stress data for the lowest energy absorption band, strongly supporting an assignment as impurity → CB electron transfer, *i.e.*, $Co^{2+}(d^7) \rightarrow [Co^{3+}(d^6)]e_b$ where e_b is a bound electron with an s-like wavefunction having significant CB parentage. This represents the first positive evidence for such an excited state of a transition metal impurity in any semiconductor. The observation of luminescence from this state with excitation by above-gap radiation suggests that the dominant energy relaxation channel through the Co^{2+} center involves sequential carrier capture.

1. D. J. Robbins, P. J. Dean, S. G. Bishop, and P. Porteous, *Solid State Commun.*, **36,** 61 (1980).

Abstract No. 165

Cathodoluminescence Measurements in the Range of 500-6000V

R. R. Wengert, Siemens AG, Grundlagenentwicklung Bereich Bauelemente, Postfach 801709, D-8000 München 80, Germany

An apparatus is described to perform CL measurements of phosphor brightness and efficiency in the range between 500 and 6000V. The electron beam current at the sample is calibrated by a special method which allows the use of not aluminized samples also. It is shown how the luminous efficiency of ZnS-phosphors and of some reference samples decreases with increasing brightness by current density enhancement at constant voltage. MgO, BeO, and Zn_2SiO_4 proved to be excellent coating materials, but the best efficiency was obtained with uncoated material.