

the experimental ground state energies for substitutional transition metals in III-V semiconductors, including those shown in Fig. 1. There is some current debate over the absolute accuracy of these calculations and the derived conclusion that the excited t_2 states usually described by the crystal field splitting are almost entirely host-like, in contrast to the ground states which are of predominantly d character. However,

the major chemical trends certainly seem to be well represented by this theory.

A transition between an open and closed shell behaviour may be observed across a series of semiconductors such as the Zn chalcogenides as a function of the differential electron affinity between the Cu impurity and host semiconductor. Green's function and cluster calculations both suggest that even transition metal impurities like Co and particularly Ni exhibit gap states in Si and GaAs which are essentially dangling bond-like, with d-like states of similar symmetry deep within the valence band. However, this conclusion may be controversial. The electronic properties of some similar systems appear to exhibit strong d-character, for example from the form of phonon coupling which appears characteristic of intrad state transitions. It has been suggested recently that the s-d interaction between host and transition metal may have been substantially over-emphasised, perhaps through neglect of stabilisation against covalent mixing by the strong interactions between d electrons. Neglect of many electron effects is a generally recognised weakness of the current status of deep level theory. Much more work needs to be done on the magnitudes of such effects, but this remains a daunting task.

one system, however. Current indications are that each system may require particular, special treatments. Excited states are hard to calculate on the self consistent basis used for ground states. However, useful generic trends have emerged within series of closely related defects or for a given defect in different binary hosts, or as a function of ternary alloy composition. An important joint outcome of the theoretical and experimental work is the recent recognition of the importance of antisite defects in the electronic properties of semiconductors.

BIBLIOGRAPHY

For a recent general review of deep levels, see Jaros M., *Deep Levels in Semiconductors* (Adam Hilger, Bristol) 1982.

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With the approval of the Executive Committee it has been decided to set up a Liquids Section of the **Condensed Matter Division**.

Individual Members of EPS interested in joining this Section should inform the Secretariat as soon as possible.

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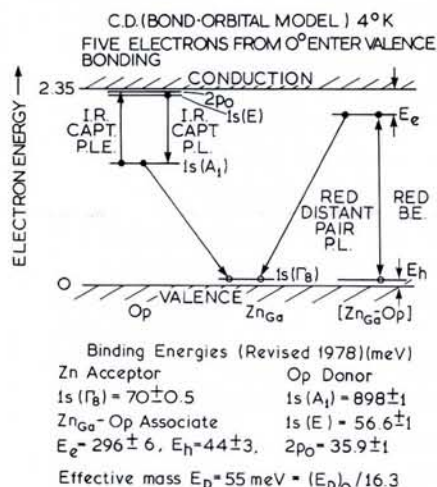


Fig. 2 — Experimental properties of the on-electron state of the deep O_p donor and the Zn_{Ga} - O_p "molecular" isoelectronic trap in GaP. A relatively unusual feature for deep levels in semiconductors is the cross-check provided from intercomparison of energies from the several different types of optical spectra indicated. PL represents photoluminescence, PLE-PL excitation, BE-bound exciton, IR capt-infra red radiative (electron) capture.

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