Zeitschrift: Helvetica Physica Acta
Band: 56 (1983)
Heft: 1-3

Artikel: Defect characterization in III-V compounds by ESR
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DOI: https://doi.org/10.5169/seals-115380

Helvetica Physica Acta,
Vol. 56 (1983) 329-330

0018-0238/83/010329-02$1.50+0.20/0

DEFECT CHARACTERIZATION IN III-V COMPOUNDS BY ESR

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The analysis of point defects in semiconductors by the technique of electron spin resonance (ESR) has its long tradition. The early work which started in the late fifties emphasized ESR studies on shallow donors and acceptors as well as on transition metal impurities in the elemental semiconductors. Here, silicon became the favourite subject of most extensive investigations. Radiation induced paramagnetic defects in silicon, as studied by ESR, soon developed into an additional topic, still remaining of high current interest.

ESR assessment of defects in III-V semiconductors has proceeded much more slowly. In these compounds the main experimental obstacles were and are (i) large ESR linewidths resulting from unresolved ligand hyperfine interaction, and (ii) low solubility of certain classes of deep impurities, as transition metals. The latter restriction is also valid for Si and Ge, but not for the more ionic II_B-VI semiconductors. Additional experimental difficulties may arise for n-type GaAs and InP, where the ionisation energy (5 - 7 meV) of shallow donors is so low, that incomplete carrier freeze-out at low temperatures may render an ESR measurement impossible.

Complementary to conventional ESR, the more recent and sophisticated technique of optically detected magnetic resonance (ODMR) now finds increasing application for defect assessment in semiconductors. By this method, also diamagnetic defects can be detected and investigated, via their excited paramagnetic triplet states. An additional advantage of the ODMR technique is the possibility that very small sample volumes, limited by the focal

area and penetration depth of the exciting laser beam, can be investigated. Thus, ODMR is ideally suited for defect characterisation in epitaxial layers.

This talk is organized as follows: In its first part a summary of present knowledge on $3d^n$ transition metal impurities in GaP, GaAs and InP, as obtained by ESR, will be given. The second part discusses in detail current ESR and ODMR investigations on the anion antisite defects P_{Ga}:GaP and As_{Ga}:GaAs. These basic and native point defects are very characteristic for III-V compounds; they are also suspected to play a key role in devices, in a deleterious as well as in a beneficial manner. Finally, the present state of ESR studies on radiation induced defects in GaP, GaAs and InP will be summarized.

For a more detailed discussion on ESR of defects in III-V semiconductors, we can refer to a recent review article on this topic /1/.

/1/ J. Schneider, "ESR of Defects in III-V Compounds", in "Defects in Semiconductors", J.W. Corbett and S. Mahajan (editors) North Holland, Materials Research Conference, Boston 1982 (in press).