

PROPERTIES OF

# Wide Bandgap II-VI Semiconductors

Edited by

**RAMESHWAR BHARGAVA**  
Nanocrystals Technology, USA



**INSPEC**  
THE INSTITUTION OF ELECTRICAL ENGINEERS

## Contents

Introduction	vii
Contributing Authors	viii
Abbreviations	xii
1 ELASTIC, STRUCTURAL AND THERMAL PROPERTIES	1
1.1 Elastic properties of ZnSe single crystals and ZnSe epitaxial layers grown on GaAs <i>M. Drozdowski, W. Bala, M. Kozielski and P. Ziobrowski</i>	2
1.2 Elastic properties of bulk ZnS and ZnTe <i>H.E. Ruda</i>	3
1.3 Elastic properties of bulk CdTe and CdZnTe <i>D.J. Williams</i>	13
1.4 Piezoelectric coefficients of widegap II-VIs <i>G. Golan, S. Amirhaghi and C.W. Pitt</i>	23
1.5 Structural, thermal and miscellaneous properties of widegap II-VIs <i>R.N. Bhargava</i>	27
2 ENERGY BAND STRUCTURE	31
2.1 Bandgaps of widegap II-VIs, temperature dependence <i>K.P. O'Donnell and P.G. Middleton</i>	33
2.2 Fermi level pinning, bandgap offsets and maximum doping limits in widegap II-VIs <i>W. Walukiewicz</i>	37
2.3 Bandgap engineering of widegap II-VI ternaries and quaternaries <i>K. Akimoto</i>	41
2.4 Bandgaps of widegap II-VI ternaries and quaternaries, temperature dependence <i>K. Akimoto</i>	53
2.5 Nanocrystals of widegap II-VIs and their bandgaps <i>E.T. Goldburt</i>	57
3 BULK AND EPITAXIAL GROWTH	63
3.1 Bulk growth and characterisation of widegap II-VIs <i>B.J. Fitzpatrick</i>	65
3.2 MBE growth of II-VI layers <i>T. Yao</i>	77
3.3 MO(GS)MBE growth of II-VI layers <i>Shizuo Fujita and Shigeo Fujita</i>	90
3.4 II-VI/III-V heterovalent interfaces <i>J. Han and R.L. Gunshor</i>	96

4	OPTICAL PROPERTIES	111
4.1	Optical absorption of widegap II-VIs as a function of temperature and pressure <i>W.G. Gebhardt and G. Schotz</i>	113
4.2	Free and bound exciton binding energies in widegap II-VI semiconductors <i>J. Gutowski, P. Baume and K. Hauke</i>	134
4.3	Nonlinear optical coefficients of widegap II-VIs <i>I.J. Blewett and A. Kar</i>	148
5	TRANSPORT PROPERTIES AND IMPURITY ENERGY LEVELS	153
5.1	Carrier mobilities of the zinc chalcogenide semiconductors <i>H.E. Ruda</i>	155
5.2	Minority carrier diffusion lengths and lifetimes in widegap II-VIs <i>T. Ido and H. Goto</i>	163
5.3	Deep impurity levels in widegap II-VI semiconductors <i>G.F. Neumark</i>	166
5.4	Compensating impurities in ZnSe and its alloys <i>Z. Zhu and T. Yao</i>	175
6	LASERS, LEDs AND OTHER APPLICATIONS	183
6.1	Barrier heights at interfaces between widegap II-VIs and metals <i>J.O. McCaldin</i>	185
6.2	Long lived II-VI lasers <i>K. Nakano and A. Ishibashi</i>	190
6.3	Optically pumped II-VI lasers <i>I. Suemune</i>	193
6.4	Electron beam pumped II-VI lasers <i>J.B. Khurgin</i>	198
6.5	Light emitting diodes and electroluminescent structures based on widegap II-VIs <i>R.N. Bhargava</i>	202
6.6	Phosphors in widegap II-VIs <i>S. Shionoya</i>	207
6.7	Solar cells made from widegap II-VIs <i>K. Saminadayar and T. Baron</i>	218
	Subject Index	233