

Generalized Infrared Ellipsometry - a new tool for characterization of semiconductor heterostructures



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Web: http://www.uni-leipzig.de/~hlp/ellipsometrie

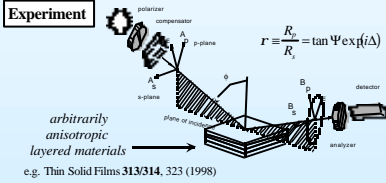
Introduction

Lattice vibrations and free-carrier absorption dominate the infrared dielectric response of thin-film semiconductor heterostructures. Infrared Spectroscopic Ellipsometry (IRSE) determines thin-film lattice modes and coupled plasmon-phonon modes of (Al,Ga,In)-(N,P,As) materials. IRSE analysis of simple heterostructures establishes an infrared dielectric function database, which allows the simultaneous analysis of

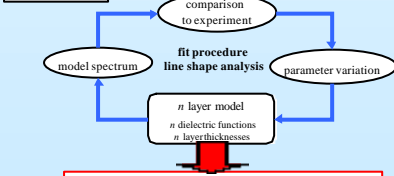
- carrier properties (mobility and concentration) in *p*- and *n*-type doped device regions,
 - geometry (layer thicknesses),
 - morphology (composition and crystal quality), and
 - strain
- in complex optoelectronic and electronic semiconductor device structures.

Infrared Ellipsometry

Experiment

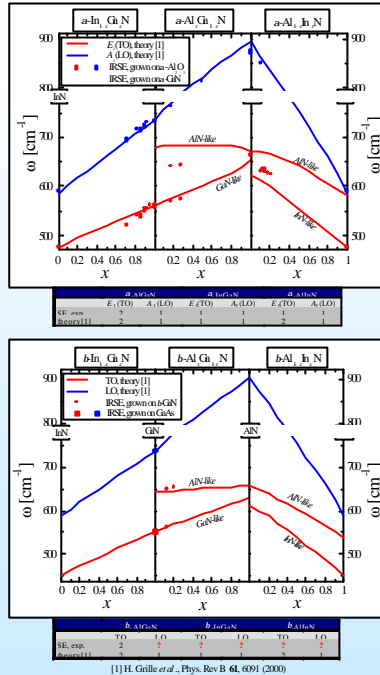


Data Analysis



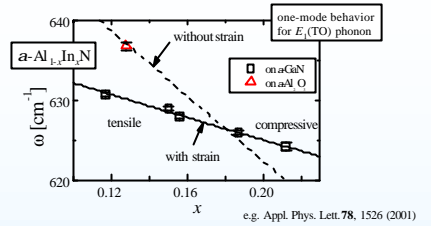
phonon mode frequencies and damping values
concentration and mobility of free carriers
layer thicknesses

Phonon modes of hexagonal and cubic group-III-nitrides

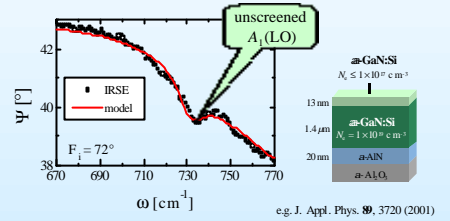


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Strain and composition



Surface carrier depletion layer



Effective carrier masses

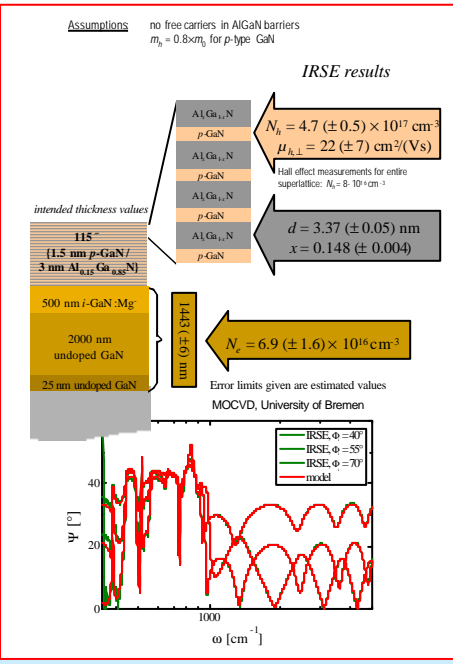
We have determined the following values so far:

a-GaN:Si, n-conductivity		a-GaN:Si, p-conductivity	
N_c [cm ⁻³]	m_e [m ₀]	N_v [cm ⁻³]	m_h [m ₀]
1.5×10^{15}	0.228 ± 0.008	0.237 ± 0.006	0.74 ± 0.17
			1.40 ± 0.33

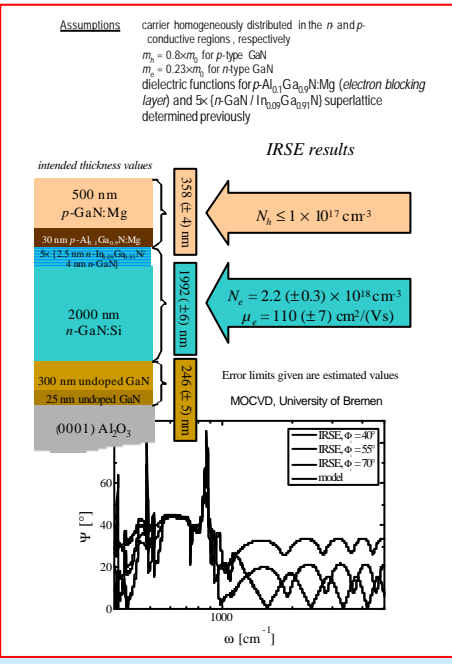
a-InN, n-conductivity	
N_c [cm ⁻³]	m_e [m ₀]
2.8×10^{17}	0.41 ± 0.010

e.g. Phys. Rev. B 62, 7365 (2000)

AlGaN / GaN superlattice structure



Group-III-nitride LED structure



Group-III-nitride laser diode structure

