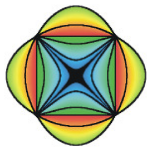
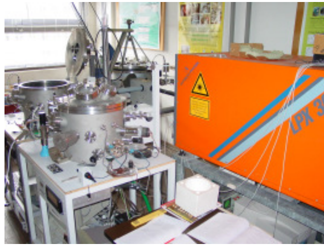


Semiconductor Physics Group
Prof. Dr. M. Grundmann

UNIVERSITÄT LEIPZIG

Our Methods

Materials Preparation

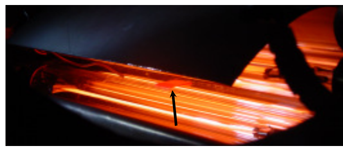

Excimer laser and three vacuum deposition chambers[3,6]

Materials:
ZnO, MgO, (Mg,Cd)ZnO, ZnO:Ga,Al, ZnO:P,N, ZnO:Co,Mn, (Ba,Sr)TiO_3, ZrO_2, HfO_2, Al_2O_3

Structures:
thin films, heterostructures and self-assembled nanostructures

Plasma plume

Pulsed laser deposition (PLD)
Annealing chamber
Tube furnace
Polishing, metal evaporation, lithography, etching, bonding


Annealing[2] of ZnO substrate at 1200°C in O_2

in cooperation with Institute for Inorganic Chemistry (Dr. Gottschalch)
Metal-organic vapor deposition (MOVPE) for III-V semiconductors
Plasma-enhanced chemical vapor deposition (PECVD)

Structural Characterization

FEM/FIB nanolab[1]

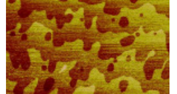
High resolution X-ray diffractometry[1]

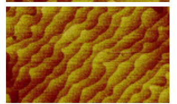
Atomic force microscopy[4]

Field emission scanning electron microscopy with focussed ion beam nanolab (FEM/FIB, EDX)
High resolution X-ray diffraction (HRXRD)
Reflection high energy electron diffraction (RHEED)
Atomic force microscopy (AFM, STM)
Surface profilometer
Secondary neutral mass spectroscopy (SNMS)

in cooperation with IMKM (Dr. Wagner)
Transmission electron microscopy (TEM, EDX)

Atomic steps on ZnO (000$\bar{1}$)

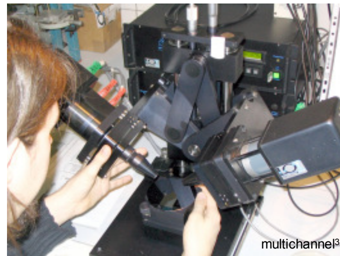




DC	1Hz - 10MHz	10MHz - 50GHz	10meV-500meV	500meV-1.5eV	1.5eV-3eV	3eV-10eV	1-50keV
DC	Electrical	HF Electronic	FIR/MIR	NIR	VIS	UV/DUV	X-ray

Ellipsometry

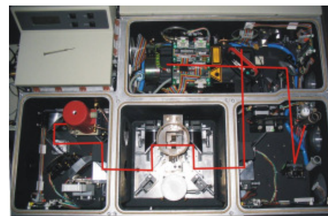
IR-VIS-UV[1]

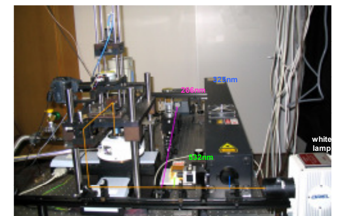

multichannel[3]

MIR[2]

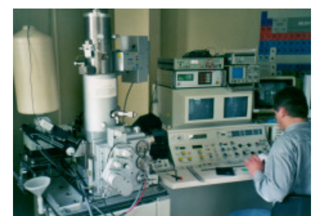
Ellipsometers for MIR, IR-VIS-UV, and DUV spectral ranges
UHV low temperature ellipsometer
Multichannel ellipsometer

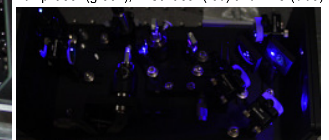
Optical Spectroscopy


Fourier-transform infrared spectroscopy[2]


Mikro-PL,-reflection and -Raman spectroscopy[2,5,6]

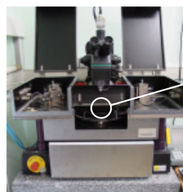
Photoluminescence spectroscopy (PL)
Micro-photoluminescence imaging (μ-PL)
Optical Pumping
Micro-reflection & -Raman spectroscopy
Scanning cathodoluminescence (CL)
Fourier-transform IR spectroscopy (FTIR)
Transmission spectroscopy
Calorimetric absorption spectroscopy (CAS)
Magneto-optical Kerr effect (MOKE)

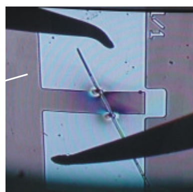

Low-temperature scanning cathodoluminescence[1]


Pump laser (green), Ti:Sa laser (red) and 2HG (blue)

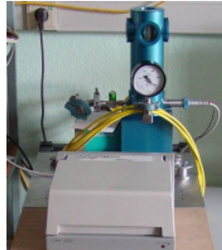
Electrical Characterization

Precision Impedance Analyzer[1]

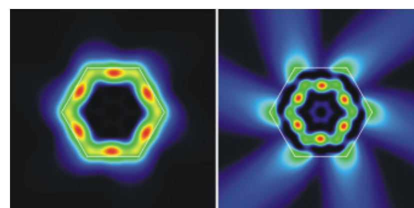

Wafer prober[1]


Probe tips testing a ZnO μwire

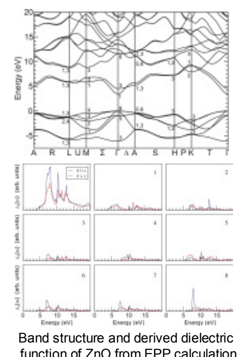
Current-voltage spectroscopy (I(V,T))
Temperature-dependent Hall effect and magnetotransport
Capacitance-voltage spectroscopy (C(ω,V,T))
Photocurrent spectroscopy (MIR/FIR, VIS/UV)
Electron beam induced current (EBIC)
Deep level transient spectroscopy (DLTS)
Sampling oscilloscope (electr., opt.)
Frequency analyzer and noise measurements
S-parameter and network analyzer
Semiautomatic wafer prober
Laser device characterization, electroluminescence


I(V) and I(V,T) measurements

Theory


Light intensity in whispering gallery modes in hexagonal ZnO nanowires

Band structure calculations with empirical pseudopotentials (EPP)
Optical modes in dielectric wave-guides
Poisson equation and depletion layers


Band structure and derived dielectric function of ZnO from EPP calculation

aquired via funds from 1:HbfG, 2: DFG, 3: BMBF, 4: BMBF FKZ03N8708, 5: industry, 6: EU

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