HL 57: Nitrides IV – Optical properties

Time: Friday 11:30–12:45 Location: POT/0051

HL 57.1 Fri 11:30 POT/0051

Optical Properties of Sn-doped n-type GaN — •Hannah Bendin[1], Elias Kluth[1], Kazuki Ohnishi[2], Kansuke Hamasaki[2], Shugo Nitta[2], Naoki Fujimoto[2], Hirotaka Watanabe[2], Yoshio Honda[2], Hiroshi Amano[2], Rüdiger Goldhahn[1], and Martin Feneberg[1] — [1]Otto-von-Guericke-Universität Magdeburg, Germany — [2]Nagoya University, Japan

GaN is at the heart of many contemporary electronic and optoelectronic applications. To increase the efficiency of high-power devices, the preparation of degenerately doped n-type GaN of high quality is required. Generally, Si and Ge are introduced as dopants, each giving rise to their own challenges. For example, high Si-doping is counteracted by carrier compensation and an increase in tensile stress. Recently, Sn has also gained interest as a dopant in GaN. Initial theoretical and experimental studies show promising results, introducing Sn as a candidate for strain control in n-type GaN via co-doping with Si or Ge, as the radius mismatch between Ga and Sn causes compressive strain, unlike Si or Ge. Here, we investigate Sn-doped samples with different carrier concentrations grown by halide vapor phase epitaxy by employing a variety of optical techniques. To determine the influence of the carrier concentration in GaN:Sn on the optical properties, we apply spectroscopic ellipsometry, Raman spectroscopy, and photoluminescence. Two sets of samples have been investigated: (I) GaN:Sn on a GaN/sapphire template and (II) GaN:Sn on a freestanding GaN substrate.

HL 57.2 Fri 11:45 POT/0051

Optical properties of ScAlN: investigation by spectroscopic ellipsometry — •Christina Harms[1], Jona Grümbel[1], Duc V. Dinh[2], Zhuohui Chen[3], Oliver Brandt[2], Martin Feneberg[1], and Rüdiger Goldhahn[1] — [1]Otto-von-Guericke-Universität, Institut für Physik, Magdeburg, Germany — [2]Paul-Drude-Institut für Festkörperelektronik, Leibniz-Institut im Forschungsverbund Berlin e.V., Berlin, Germany — [3]Huawei Technologies Canada Co., Ltd., Kanata, Canada

$Sc_xAl_{1-x}N$ alloys are of increasing interest due to their unique ferroelectric and optoelectronic properties. In this work, we investigate the dielectric function of this material using spectroscopic ellipsometry. A series of $Sc_xAl_{1-x}N$ samples with $0 \leq x \leq 0.35$, grown on AlN/Si by plasma-assisted molecular beam epitaxy, were measured in the infrared (IR) and ultraviolet (UV) spectral range. In the IR range, the E_1(TO) phonon mode is characterized in terms of its resonance frequency ω and broadening γ, which are analyzed as a function of Sc content. Additionally, the dielectric limit ε_∞ is derived. With increasing Sc content, ω decreases, while both γ and ε_∞ increase. In the UV range, we determine the optical bandgap E_g as well as the corresponding ε_∞ and describe the observed trends across the composition range. Here, E_g decreases systematically with increasing Sc content and ε_∞ increases accordingly. The results are compared with recent results from literature, showing consistent trends in the optical properties throughout the investigated composition range.

HL 57.3 Fri 12:00 POT/0051

Near-lattice-matched AlScN/GaN heterostructures studied by spectroscopic ellipsometry and photoluminescence — •Alwin Wüthrich[1], Rajendra Kumar[2], Oana Malis[2], Rüdiger Goldhahn[1], and Martin Feneberg[1] — [1]Institut für Physik, Otto-von-Guericke-Universität Magdeburg, Germany — [2]Department of Physics and Astronomy, Purdue University, USA

Understanding the fundamental properties of the novel ferroelectric material AlScN, such as ferroelectricity, tunable lattice constants, a wide and tunable band gap, and high piezoelectric coefficients, is crucial for its correct implementation in modern applications. Examples include processing units based on non-volatile memory and the design of infrared devices that utilize transitions between strongly confined electronic states, i.e., intersubband transitions. Here, near-lattice-matched AlScN layers (with 4–25% Sc) were grown by molecular beam epitaxy (MBE) on MBE-grown GaN layers. The samples were investigated by spectroscopic ellipsometry from the near-infrared to the far-ultraviolet range, probing infrared-active phonons and interband transitions. Additionally, the samples were studied by temperature-dependent photoluminescence, revealing luminescence from a two-dimensional electron gas.

HL 57.4 Fri 12:15 POT/0051

Near-Infrared Photocurrent Spectroscopy of InN Two-Terminal Devices — •Alexandra V. Nemmaier[1,2], Maximilian A. Gruber[1,2], Abhilash Ulhe[1,2], Gregor Koblmüller[1,2], and Alexander W. Holleitner[1,2] — [1]Walter Schottky Institute, TU Munich, Germany — [2]Exzellenzcluster e-conversion, Munich, Germany

The semiconductor InN, with its narrow bandgap, high electron mobility, and specific carrier cooling mechanisms, is a promising platform for optoelectronics and hot carrier solar cells. We investigate epitaxial InN layers grown on GaN by near-infrared photocurrent spectroscopy. We measure the spatially resolved photocurrent to characterize the photoresponse in gated two-terminal devices. This approach offers a new perspective on hot carrier generation, charge carrier transport, and relaxation mechanisms close to the bandgap of the material.

HL 57.5 Fri 12:30 POT/0051

Structural and vibrational properties of strain-free $Al_{1-x}Sc_xN$ nanowires — Adriano Notarangelo[1], Ileana Florea[2], Philippe Vennéguès[2], Aidan Campbell[1], Hans Tornatzky[1], Jonas Lähnemann[1], Thomas Auzelle[1], Lutz Geelhaar[1], Oliver Brandt[1], and •Philipp John[1] — [1]Paul-Drude-Institut für Festkörperelektronik, Leibniz-Institut im Forschungsverbund Berlin e.V. 10117 Berlin, Germany — [2]Université Côte d'Azur, CRHEA, CNRS, 06905 Sophia-Antipolis Cedex, France

The incorporation of Sc into the wurtzite crystal lattice of AlN enhances its piezoelectricity and induces ferroelectricity, making $Al_{1-x}Sc_xN$ an attractive material for novel types of group-III nitride based devices. Yet, the lattice distortions giving rise to these functionalities are superimposed to distortions arising from residual strain introduced during the heteroepitaxy on lattice-mismatched substrates.

In this work, self-assembled wurtzite $Al_{1-x}Sc_xN$ nanowires are grown by molecular beam epitaxy, varying the Sc content x from 0 to 0.38. The nanowire geometry allows elastic relaxation to occur, resulting in strain-free, bulk-like $Al_{1-x}Sc_xN$. A non-linear evolution of lattice parameters and a continuous red-shift of the E_2^{high} and A_1(TO) phonon modes as a function of Sc content are found, confirming its incorporation into the wurtzite lattice and revealing modifications of anion-cation bond strength and coordination environment.

Our results highlight the advantages of bulk-like $Al_{1-x}Sc_xN$ for probing its fundamental properties, laying the ground work for further device applications.