

Spectroscopic Ellipsometry Focus Topic

Room 304 - Session EL1+AS+EM-TuA

Emerging Technological Advances and Breakthroughs of Spectroscopic Ellipsometry

Moderators: Alain Diebold, SUNY Polytechnic Institute, Ruediger Schmidt-Grund, Technical University Ilmenau, Germany

2:20pm **EL1+AS+EM-TuA-1 Terahertz to Vacuum Ultraviolet Ellipsometry Characterization of Spin, Lattice, Strain, Free Charge Carrier, Dielectric Constants, Exciton and Band-to-Band Transition Properties in Ultrawideband Gap Alpha and Beta Aluminum Gallium Oxide Semiconductor Alloys**, *Mathias Schubert*, R. Korlacki, M. Stokey, University of Nebraska-Lincoln; A. Mock, Weber State University; M. Hilfiker, University of Nebraska-Lincoln; J. Knudtson, University of Nebraska-Lincoln, USA; U. Kilic, University of Nebraska-Lincoln; S. Richter, Lund University, Sweden; S. Knight, P. Kuehne, Linkoping University, Sweden; V. Darakchieva, Lund University, Sweden

INVITED

Two phases of ultrawideband gap semiconductor gallium oxide emerge in composition with aluminum, the rhombohedral alpha and monoclinic beta phase of AlGaO. Progress in epitaxial deposition provides quality materials investigated currently with large efforts. Both phases permit access to ultrawideband gap properties reaching approximately 9 eV with sapphire. We employ a wide range of ellipsometry techniques covering 100 GHz to approximately 9.5 eV, including magnetic fields and density functional theory calculations. We provide an overview of current knowledge of properties for both compounds, discussing strain-stress relationships, evolution of phonon mode and band to band transition behaviors, dielectric constants, indices of refraction, anisotropy, and free charge carrier and defect properties [1-8]. We report on a new hyperbolic shear polariton formation in monoclinic Ga₂O₃ [9]. We also report on initial results of our newly developed instrumental approach for defect characterization in quantum materials, THz electron paramagnetic resonance ellipsometry for ultrahigh field and high resolution frequency spin detection and analysis in epitaxial semiconductor layer systems [10]. [1] M. Stokey et al., Phys. Rev. Materials 6, 014601 (2022). [2] M. Hilfiker et al., Appl. Phys. Lett. 118, 062103 (2021). [3] M. Hilfiker, U. Kilic, M. Stokey, R. Jinno, Y. Cho, H. Grace Xing, D. Jena, R. Korlacki, and M. Schubert, Appl. Phys. Lett. 119, 092103 (2021). [4] R. Korlacki, M. Stokey, A. Mock, S. Knight, A. Papamichail, V. Darakchieva, and M. Schubert, Phys. Rev. B 102, 180101(R) (2020). [5] P. Gopalan, S. Knight, A. Chanana, M. Stokey, P. Ranga, M. Scarpulla, S. Krishnamoorthy, V. Darakchieva, Z. Galazka, K. Irmscher, A. Fiedler, S. Blair, M. Schubert, and B. S. Rodriguez, Appl. Phys. Lett. 117, 252103 (2020). [6] M. Hilfiker, U. Kilic, A. Mock, V. Darakchieva, S. Knight, R. Korlacki, A. Mauze, Y. Zhang, J. Speck, and M. Schubert, Appl. Phys. Lett. 114, 231901 (2019). [7] J. A. Spencer, A. L. Mock, A. G. Jacobs, M. Schubert, Y. Zhang, and M. J. Tadjer, Appl. Phys. Rev. 9, 011315 (2022). [8] R. Korlacki, J. Knudtson, M. Stokey, M. J. Hilfiker, V. Darakchieva, and M. Schubert, Appl. Phys. Lett. 120, 042103 (2022). [9] N. Passler, X. Ni, G. Hu, J. R. Matson, M. Wolf, M. Schubert, A. Alù, J. D. Caldwell, T. G. Folland, and A. Paarmann, Nature 602, 595 (2022). [10] M. Schubert, S. Knight, S. Richter, P. Kuehne, V. Stanishev, A. Ruder, M. Stokey, R. Korlacki, K. Irmscher, P. Neugebauer, and V. Darakchieva, Appl. Phys. Lett. 120, 102101 (2022).

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