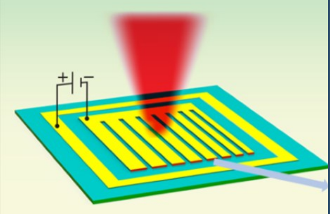
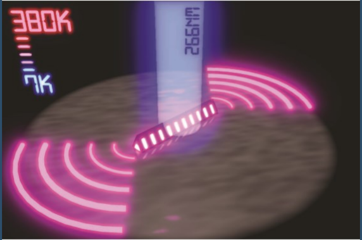
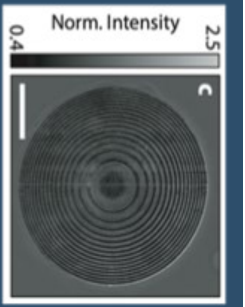
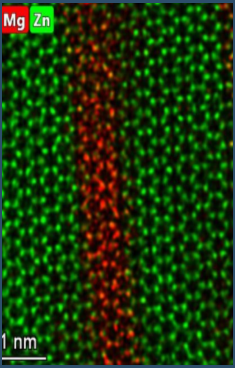
2020

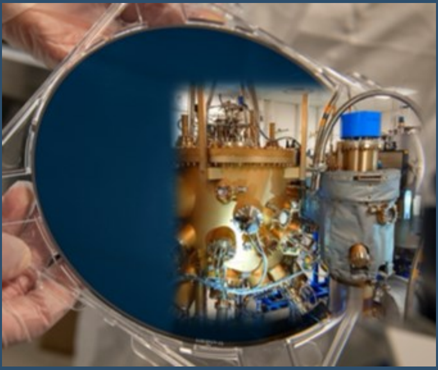
Une année avec le CRHEA

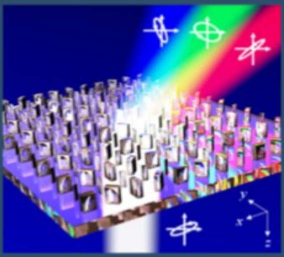


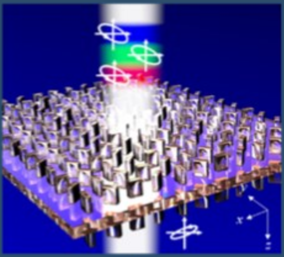


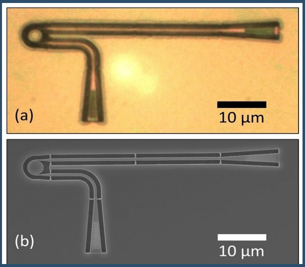












EDITORIAL

2020 has been for all of us a very particular year. The lockdown has forced us to stop our experimental activities for a long time. We have done our best with teleworking but it is unfortunately not an option for epitaxial growth, processing and characterization. Despite this difficult environment, CRHEA was able to achieve significant breakthroughs. We are very happy to present some of them in this booklet.

CRHEA has a long-standing collaboration with RIBER, a molecular beam epitaxy manufacturer. A MBE reactor, compatible with 200 mm diameter wafers was recently installed in CRHEA's premises. In collaboration with Easy-GaN, a spin-off company from CRHEA, we have demonstrated the epitaxial growth of III-nitrides on 8 inches silicon wafers using ammonia as nitrogen source. It is a new standard for III-Nitrides MBE. This exciting result opens novel perspectives for the development of GaN-on-silicon for power electronics and radio-frequency devices. The very positive feedbacks from our partners motivate us to continue in this direction.

CRHEA has also demonstrated for the first time the molecular beam epitaxial growth of Mg3N2. This breakthrough is part of a more ambitious project to develop zinc magnesium oxynitrides for transparent electronics. A young researcher, Hélène Rotella, has been hired by CNRS as research associate on this topic and we are more than happy to welcome her. Congratulations Hélène. The metasurface activity at CRHEA continues to be flourishing. Novel concepts on polarization control and beam steering have emerged. Proof of concepts have been demonstrated with exciting opportunities to reach soon the market. More news to come, for sure. Many other remarkable results were obtained on electronic and optoelectronic devices. Just have a look in the booklet. Seven students have started their PhD this year, some of them with the support of Labex Ganex.

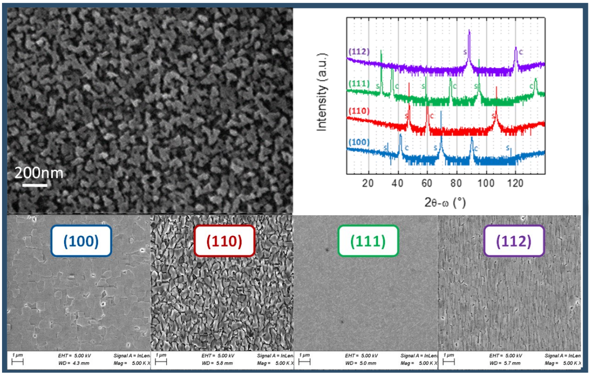
EDITORIAL

A laboratory like CRHEA cannot succeed without state-of-the-art equipments. Despite the lockdown, we were able to extend our cleanroom, as planned, and to install a novel etching equipment. The ICP-RIE reactor was purchased with the support of CNRS-INP, Région Sud and CRHEA's own funds. 2020 was as well an important milestone for us in microscopy. We have ordered a novel transmission electron microscope, a project initiated at least more than three years ago. A TEM is an expensive tool but we had some bright and generous sponsors! I just want to thank here, once again, for their support CNRS-INP, Université Côte d'Azur, IMRA Europe, Région Sud and European FEDER. The TEM should become operational by mid 2021.

A research organization is in permanent evolution. Numerous debates were launched during this year in the context of the novel research programming law. We are as well thinking about our future. We have launched the CRHEA 2025 initiative to think collectively on our research strategy, the topics we would like to focus on, and on our organization. We are as well addressing the environmental footprint of our research activities following the labos 1point5 initiative. Let's work for a different and sustainable future.

Philippe Boucaud
Director of CRHEA

Solid State Epitaxy of 3C-SiC



Top left: 5nm thick 3C-SiC(111) layer .
Bottom: Morphology after CVD regrowth of 1µm 3C-SiC; various orientations.
Top right: $2\theta-\omega$ scans of regrown epilayers - 3C-SiC has the same orientation as Si substrate.

New approach to create ultra-thin 3C-SiC/Si templates

The idea to form compound semiconductor SiC by using either high dose carbon (C) implantation into silicon (Si) crystal or surface deposition of thin C film on Si is present in the literature since early 70's. However, all the sources report only about the formation of low quality, poly-3C-SiC layers.

We achieved successful transformation of a-C thin films deposited on Si by Plasma Immersion technique (IBS) into oriented 3C-SiC seed through solid state epitaxy under controlled high temperature annealing.

The thickness of created 3C-SiC depends on initial thickness of a-C and can be further tuned by adjusting annealing temperature and duration.

The treatment was successfully applied on various Si orientations: (100), (111), (112) and (110). Oriented character of created 3C-SiC was confirmed by performing CVD regrowth of thick, high quality film.

The approach opens new possibilities for growing 3C-SiC on 3D-stuctured Si substrates (ex. Inverted Silicon Pyramids) and for template application of 3C-SiC in III-N epitaxy.

Breakthrougs

Oriented 3C-SiC layer with controlled thickness was obtained by high temperature annealing of amorphous Carbon film on Silicon substrate.

Perspectives

New possibilities for growing 3C-SiC on 3D-stuctured Si substrates.
Template application in III -N epitaxy.

Collaborations : NOVASiC, Ion Beam Services
More information : E.U. project CHALLENGE,
Contact : Marcin Zielinski _ mzielinski@novasic.com _ mz@crhea.cnrs.fr

Electrical leakage in GaN Schottky diodes

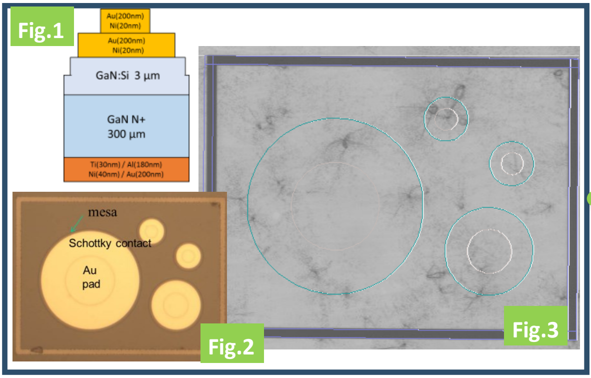


Fig 1 : Cross section view of GaN vertical Schottky diodes fabricated on a free standing GaN substrate.

Fig 2: Top view of diodes

Fig 3: Cathodoluminescence image of the surface showing the presence of dislocation clusters in regions possibly occupied by Schottky diode devices.

Dislocation clusters are not guilty

Free-standing GaN substrate is an industrial solution to provide the thick high crystal quality material necessary for the fabrication of high voltage power rectifiers. Although dislocations are often cited as responsible for the electrical leakage and the failure of electron devices, clear correlation with structural defects is still lacking. For this purpose, CRHEA and Saint-Gobain Lumilog have developed a method to locate particular defect arrangements (clusters) within GaN Schottky diodes. This method helped to show the absence of correlation between such defects and any electrical leakage or breakdown up to a reverse bias of 200 V.

Breakthroughs

The study evidenced the absence of correlation between the presence of dislocation clusters and electrical leakage current in GaN Schottky diodes.

Perspectives

Identification of defects responsible for the electrical leakage.
Study of other devices like p-n diodes.

Collaborations : Saint Gobain Lumilog
More information : Thi Huong Ngo et al, J. Crystal Growth 552 (2020) 125911,
https://doi.org/10.1016/j.jcrysgro.2020.125911
Contact : Yvon Cordier _ yc@crhea.cnrs.fr

E-D mode GaN HEMTs based on evaporation

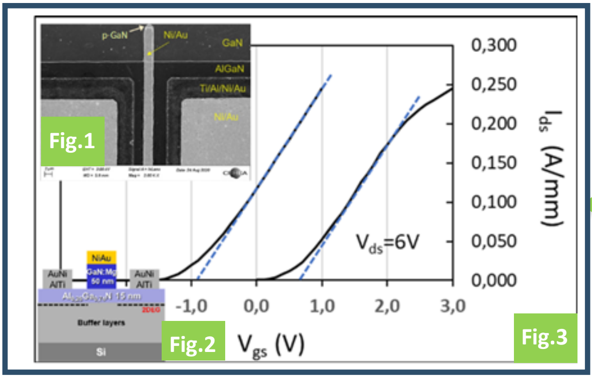


Fig 1: Scanning electron microscope top view

Fig 2: Cross section sketch of an E-mode transistor fabricated with a p-GaN gate defined by sublimation.

Fig 3: Transfer electrical characteristics of E-mode and D-mode transistors co-integrated on the same wafer thanks to selective evaporation.

GaN sublimated

The fabrication of normally-off (E-mode) GaN transistors is of high interest for power and high frequency applications. However, one of the most popular process based on the dry etching of a p-doped GaN cap layer is highly critical due to damages possibly induced by the plasma etching techniques. To tackle such difficulty, CRHEA and its partners have developed a soft etching technique based on the evaporation of GaN under vacuum (sublimation).

Such evaporation is selective towards Al containing alloys like AlGaN and SiO_2 or SiN_x masks. A careful design of the device active layers makes its possible to co-integrate normally-on (D-mode) transistors with E-mode ones in a same monolithical circuit.

Breakthroughs

The fabrication of GaN electron devices with a soft etching technique and the co-integration of E-mode with D-mode transistors.

Perspectives

Fabrication of submicron gate high frequency devices.

Combination with selective area growth for advanced devices and circuits.

Collaborations : LN2, IEMN, IMS, OMMIC (ANR project ED-GaN)
More information : Thi Huong Ngo et al, Semicond. Sci. Technol. 36 (2020) 024001, https://doi.org/10.1088/1361-6641/abcbd3
Contact : Yvon Cordier _ yc@crhea.cnrs.fr

Record power density RF HEMT on GaN

Fig.1

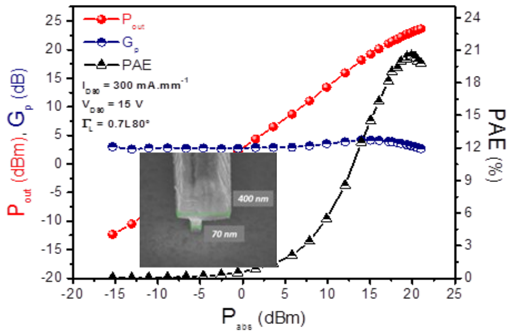


***Fig 1**: Output power, power gain and power added efficiency versus absorbed power at 40 GHz for a $2 \times 50 \times 0.07\ \mu m^2$ AlGaN/GaN HEMT on Free-Standing GaN substrate. The insert shows the 0.07 µm footprint gate.*

A new record power density at 40 GHz on commercial GaN substrate

The development of performant and reliable GaN high-electron-mobility transistors (HEMTs) on high crystal quality GaN is hampered by the lack of large lattice matched substrates available at reasonable cost. In this context, the growth of GaN HEMTs on commercial free-standing GaN substrates previously developed for high brightness light emitting diodes has been investigated as an alternative approach for high frequency applications. After the demonstration of high quality surface despite the growth of 10 to 40 µm thick highly resistive GaN buffer layer to limit the capacitive coupling between the active regions at the top and the conductive substrate at the bottom, 70 nm gate footprint transistors have been successfully fabricated.

A 100 GHz maximum intrinsic cutoff frequency f_T, and a maximum intrinsic oscillation frequency f_{Max} of 125 GHz are obtained from S-parameters measurement. A record output power density of 2 W/mm, associated with 20.5 % power added efficiency and a linear power gain (Gp) of 4.2 dB is demonstrated at 40 GHz.

Breakthroughs

Record power density at 40 GHz on commercial GaN substrate doubles the previous state of the art.

Perspectives

Further enhance the performance by optimizing the epitaxial structure.

Collaborations : IEMN, LUMILOG, LAAS (ANR-11-LABX-0014, Investissements d'Avenir, 'GaNeX')
More information : Semicond. Sci. and Technol, https://doi.org/10.1088/1361-6641/ab4e74
Contact : Yvon Cordier _ yc@crhea.cnrs.fr

The roots of the evil

Fig.1

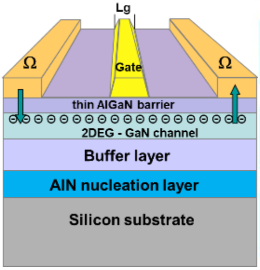


Fig.2

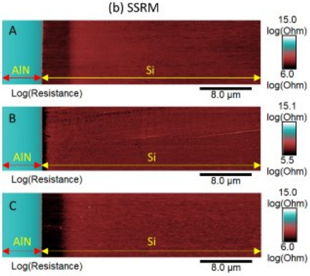


Fig 1: Cross section view of a GaN high electron mobility transistor on Silicon.

Fig 2: Scanning spreading resistance microscopy map showing the presence of a conductive p-channel induced by the MOCVD growth at the AlN/Silicon interface. The p-channel in Sample B grown at lower temperature is much less conductive.

MOCVD is the preferred epitaxy technique to produce the GaN transistor heterostructures suitable for high-power high-frequency telecommunications. The growth on large diameter low cost substrates like Silicon is required to reduce production cost, but such route faces some difficulties to produce efficient microwave devices due to losses. In collaboration with IEMN and GREMAN, one source of losses has been identified.

Scanning microscopy with electrical modes confirms that one main source of RF losses is a parasitic p-type channel located at the interface between the AlN nucleation layer and Silicon. It is due to a p-type doping of the Silicon substrate with Gallium, which can be mitigated by reducing the growth temperature and by optimizing the reactor cleaning.

Breakthroughs

The study evidenced the origin of RF losses in GaN HEMTs grown by MOCVD on Silicon.

Perspectives

Development of reactor cleaning procedure and alternative ways to grow GaN HEMTs by MOCVD.

Collaborations : GREMAN, IEMN (ANR ASTRID project GoSiMP)
More information : Micka Bah et al, Scientific Reports (2020) 10, 14166. https://doi.org/10.1038/s41598-020-71064-0
Contact : Yvon Cordier yc@crhea.cnrs.fr

III-nitride photonic platform on silicon: integration of ultraviolet microdisk lasers

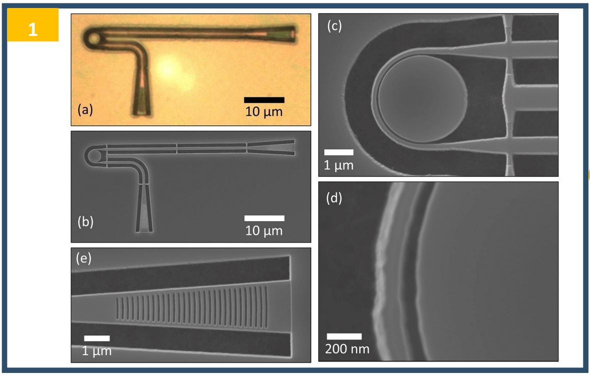


Fig 1 : (a) Optical microscope image and (b) SEM image of a pho- tonic circuit. Zoom-ins of (c) the micro-disk, (d) the coupling region, and (e) the grating coupler.

Active III-nitride photonic circuits cover the UV range

Photonic circuits in the UV have recently gained strong popularity with potential applications including atomic clocks and precision metrology. Several passive circuits in the UV have been demonstrated using aluminum nitride (AlN) but no demonstrations of active photonic circuits containing microlasers in the UV have been reported so far. We have demonstrated active microlaser photonic circuits in the UV spectrum, consisting of a microdisk, a pulley waveguide, and outcoupling gratings terminating the waveguide. The laser emission is in the UV-A spectral range around 380 nm. The distance between the microsdisk laser and the suspended pulley waveguide is as small as 50 nm. The devices operate at the limit of what can be achieved using GaN as the waveguiding layer.

In parallel, an analysis of low-threshold III-nitride microdisk lasers on silicon has been performed. Thresholds in the range of 18 kW cm^{-2} at room temperature have been achieved for structures on silicon. Thresholds in the few kW cm^{-2} range constitute the best that can be achieved with III-nitride quantum wells.

Breakthroughs

An active photonic circuit with microlasers in the UV-A spectral range integrated on silicon

Perspectives

To demonstrate room temperature microdisk lasers on silicon under cw excitation.

To develop III-nitride photonic circuits under electrical injection

To develop photonic circuits for integrated nonlinear sources

Collaborations : CRHEA – C2N – CEA-IRIG – L2C ; ANR project Milagan
More information: F. Tabataba-Vakili et al., Opt. Lett. 45, 4276 (2020) ; APL 117, 121103 (2020)
Contact : Philippe Boucaud – Fabrice Semond

MBE of III-N epilayers on 200 mm wafers

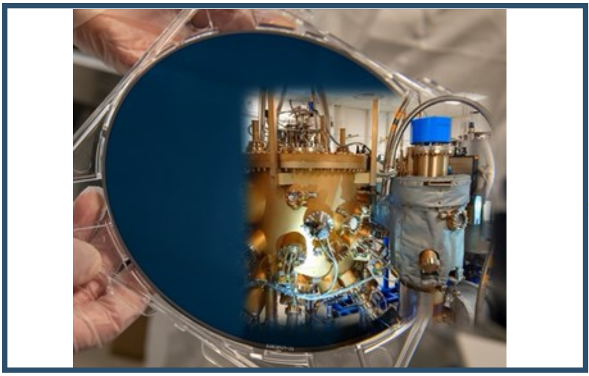


Fig : A 100 nm thick AlN epilayer grown by Molecular Beam Epitaxy on a 200 mm silicon wafer. Also shown is a picture of the Riber MBE 49 growth reactor installed at the CRHEA laboratory.

How to assess innovations made by epitaxy for commercial applications

III-N semiconductor materials (GaN, AlN, InN and their alloys) have revolutionized the lighting industry and will participate to the renewal of power and microwave electronics. Academic research and R&D actors are in demand for innovative III-N epitaxy solutions to develop new concepts and to make the component technologies of tomorrow more reliable.

As part of a collaboration between CRHEA and Riber, an MBE reactor (MBE 49) dedicated to III-nitrides growth and working on industry compatible wafers has been installed at CRHEA. This equipment offers different wafer configurations: 1x6”, 1x8”, 3x4” up to 13x2” and allows to produce epitaxial layers in large quantities with great reproducibility in order to answer industrial needs. Researchers and R&D players can have access to this equipment to evaluate and/or to validate their epitaxy innovations. In addition, partners benefit from the high technical skills and scientific expertise of CRHEA, which has more than a quarter of a century of experience in epitaxy and characterization of large bandgap semiconductors heterostructures and devices (LEDs, HEMTs ...).

Breakthroughs

A specific AlN-on-Si process using NH_3-MBE has been successfully transferred to 200 mm substrate.

This achievement is particularly important because this step is a key issue for GaN-on-Si epitaxy which is a promising material solution for RF and Power electronics as well as emerging applications in optoelectronics and photonics.

Perspectives

MBE has several advantages that could attract future developments

- better interfaces,
- low growth temperature,
- no hydrogen passivation,
- uniformity easily achieved

Collaborations : CRHEA – Riber – STMicroelectronics – CEA-Leti – EasyGaN

Contact : Philippe Boucaud – Fabrice Semond

A ZnO based quantum cascade emitter

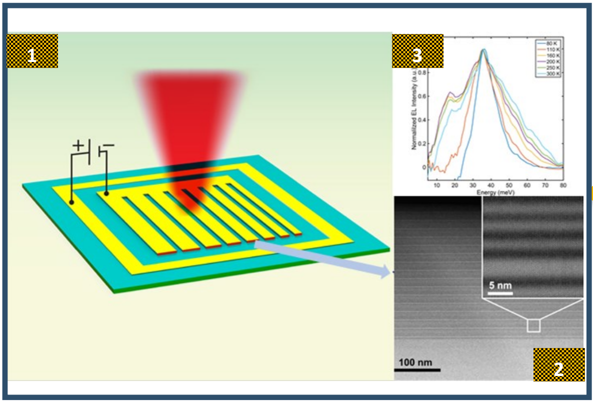


Fig 1: Schematic of the fabricated devices.

Fig 2: Scanning transmission electron microscopy image in the cross-section of ZnO/$Zn_{88}Mg_{12}O$ cascade structure

Fig 3: Temperature evolution of the electroluminescence spectra for temperatures from 80 K to

Room temperature THz electroluminescence

The ZnO based heterostructures are promising candidates for optoelectronic devices in the infrared and terahertz (THz) spectral domains owing to their intrinsic material properties. Specifically, the large ZnO LO-phonon energy reduces the thermally activated LO-phonon scattering, which is predicted to greatly improve the temperature performance of THz quantum cascade lasers. However, to date no experimental observation of intersubband emission from ZnO optoelectronic devices has been reported. Here, we report the observation of THz intersubband electroluminescence up to room temperature from ZnO/$Mg_xZn_{1-x}O$ quantum cascade structures grown on non-polar m-plane ZnO substrates. The electroluminescence peak shows a center frequency of ~8.5 THz at 300 K, which is not accessible for GaAs-based quantum cascade structures because of the reststrahlen band absorption from 8 to 9 THz. This result is an important step towards the realization of ZnO-based THz quantum cascade lasers.

Breakthroughs

First demonstration of a THz emitter from a ZnO based quantum cascade device.

Emission in the GaAs forbidden band.

Emission at room temperature.

Perspectives

- Room temperature THz quantum cascade lasers
- Quantum cascade lasers emitting in the GaAs restrahlen band.

Collaborations : UPM Madrid, ETH Zurich, TU Wien, C2N

More information : www.zoterac.eu, B. Meng et al. ACS Photonics (in press)

Contact : Jean-Michel Chauveau _ jmc@crhea.cnrs.fr

Full optical characterization of metasurfaces

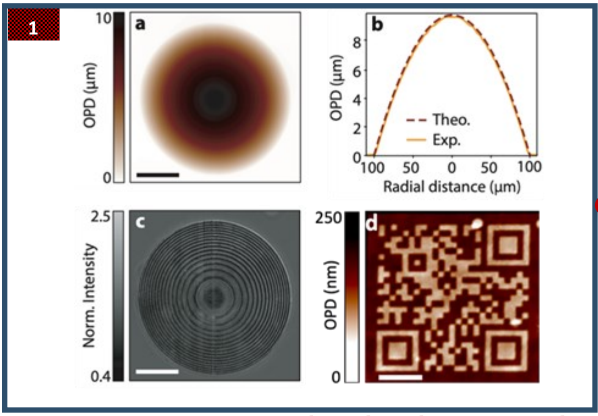


***Fig1**: Characterization of metasurfaces using Quadriwave Lateral Shearing Interferometry (QLSI) technique. a) Optical path difference (OPD) or equivalently phase and c) intensity images of a metalens measured by QLSI, b) cross section of the OPD image showing very good agreement with the expected theoretical profile. d) OPD image of a metasurface encoding a QR code of the CRHEA-CNRS website. Scale bare: 50 µm*

We measure both phase and intensity profiles at the metasurface plane thanks to a simple and efficient quantitative microscopy technique

Designing a metasurface with a specific functionality usually relies only on predictions obtained from numerical simulations. To further help improve the design of metasurfaces, precise and versatile post-characterization techniques need to be developed. Today, most of the used techniques rely on light intensity measurements. Here, we demonstrate how quadriwave lateral shearing interferometry (QLSI), a quantitative phase microscopy technique, can achieve full optical characterization of metasurfaces of any kind, as it can probe the local phase imparted by a metasurface with high sensitivity and spatial resolution. This allows the extraction of many other optical properties such as aberration coefficients and focusing properties for metalenses.

Breakthroughs

The ability to quantitatively measure phase and intensity profiles at the metasurafce plane enables the determination of all needed optical properties making QLSI a very powerful technique for metasurface characterization.

Perspectives

Based on the capabilities of metasurfaces, we aim to develop a vectorial wavefront analyser capable to characterize vectorial metasurfaces, i.e., measure simultaneously, intensity, phase and polarization profiles.

Collaborations : Institut Fresnel, Phasics
More information : arXiv:2008.11369 (2020) and **Nanophotonics, Ahead of Print (2020)**
Contact : Samira Khadir _ sk@crhea.cnrs.fr

Polarization-Maintaining Metasurfaces

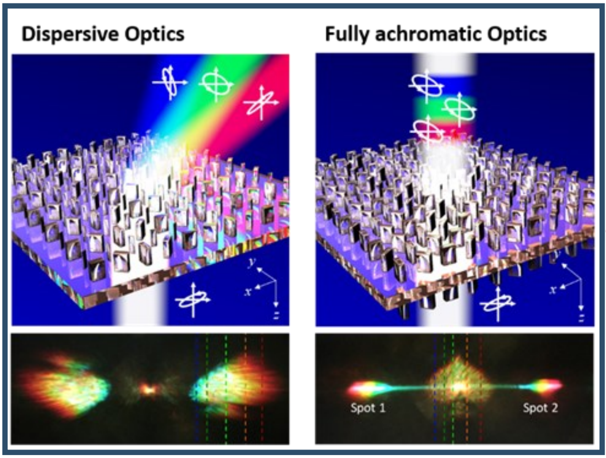


***Fig** : Left. A classical diffractive optical component that disperses light and tumbles polarization as a function of the wavelength.*
Right. A fully achromatic component controls the light properties, including amplitude, phase and also polarization over a broad spectral range.
Bottom : Holograms created by a diffractive metasurface and an achromatic polarization-maintaining metasurfaces respectively.

We address broadband full-polarization properties of diffracted fields using a superposition of circular polarization beams transmitted through metasurfaces.

Any arbitrary state of polarization of a light beam can be decomposed into a linear superposition of two orthogonal direction of the oscillations, each of which has a specific amplitude of the electric field. The dispersive nature of diffractive and refractive optical components generally affects these amplitudes significantly over a small wavelength range, tumbling the light polarization properties.

Broadband polarization maintaining is achieved using metasurfaces.

The idea consists in using a unique nanoscale building block to realize the metasurface, superposing two orthogonal polarization states so as to eliminate the dispersive response of the structures.

Breakthroughs

Full polarization generation is established over an exceptionally unlimited bandwidth, experimentally demonstrated across the entire visible range from 475 nm to 675 nm

Perspectives

Full-color & AR/VR displays, broadband polarizaition camera, vector beam generation, …

More information : Q. Song, S. Khadir, S. Vézian, B. Damilano, P. D. Mierry, S. Chenot, V. Brandli, P. Genevet, Science Adv. (in press 2020)

Contact : Patrice Genevet : pg@crhea.cnrs.fr

Crystalline Mg_3N_2: From epitaxial growth to fundamental physical properties

1

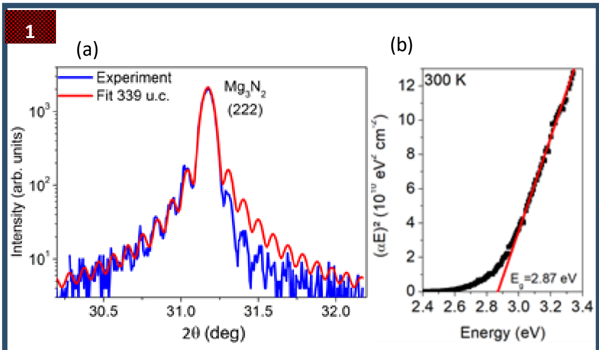


Fig 1: (a) High-resolution X-ray diffractogram of theMg$_3$N$_2$ (222) reflection. The presence of interference fringes surrounding the main peak enables the extraction of the film thickness and proves a high crystal coherence in the out-of-plane direction. (b) Tauc plot extracted from transmission measurements for the determination of the optical bandgap.

Mg_3N_2: a new semiconductor grown in CRHEA

The research of new semiconductors is of paramount importance for the development of optoelectronic devices displaying enhanced performances or new functionalities

When a new semiconductor is synthesized, it is essential to fabricate in the form of high-quality material to insure that the measurement of its fundamental physical properties (e.g. lattice parameters, electron effective mass or bandgap) are not perturbed by the presence of defects.

In this work we grow for the first time single crystalline Mg_3N_2 thin films by molecular beam epitaxy: we have first demonstrated the epitaxial character of our Mg_3N_2 thin films and, then, measured some of the material's fundamental physical properties, including its linear thermal expansion coefficient and its optical bandgap. These are essential parameters to design new alloys and heterostructures based on this new semiconductor.

Breakthroughs

- MBE growth of single-crystalline Mg_3N_2 films
- Determination of its fun damental physical properties
- Development of an MgO capping layer that prevents the otherwise irreversible oxidation in air

Perspectives

- Alloying with Zn_3N_2 for small gap applications (e.g. solar cells)
- Heterostructures of Mg_3N_2/(Zn,Mg)$_3$N$_2$/Zn_3N_2 for electronics

Collaborations : Semiconductor Physics Group (University Leipzig, Germany)
More information : Phys. Rev. Mater. **4**, 054601 (2020)
Contact : Jesus Zuniga : jzp@crhea.cnrs.fr

ICP-RIE CORIAL 210IL

Fig : Inductively coupled plasma - Reactive-ion etching.

ICP Source (RF 2000W/ 2MHz),
Cathode (RF 600W/13.56Mhz)
Gas lines : Cl2/BCl3/HBr/CH4/CHF3/C4F8/SF6/H2/O2/Ar/N2
Bosch-like process
End point detection (673.4nm)
Samples up to 200mm diameter

New high density plasma etching equipment

The Inductively coupled plasma (ICP) source generates a high-density plasma due to inductive coupling between the *radiofrequency* (RF) antenna and the plasma. The antenna, located in the plasma generation region, creates an alternating RF magnetic field and induces RF electric fields, which energize electrons that participate in the ionization of gas molecules and atoms at low pressure. The key differentiation between ICP RIE and reactive ion etching (RIE) is the separate RF power source connected to the cathode that generates DC bias and attracts ions to the wafer. Thus, ICP-RIE can achieve high etch rates by high ion or radical densities, while high material selectivity and low surface damage is achieved by using low ion energies. High density plasmas created by ICP systems can operate at low pressures and can yield significantly improved profile control for very deep, anisotropic etches. The equipment was co-financed by La Région Sud, CNRS-INP and CRHEA's own budget. The equipment was installed in September 2020 in a new extension of the CRHEATEC cleanroom.

Breakthroughs

Homogeneous etching up to 200mm

Perspectives

Etching of new materials
With 11 gas lignes, process of a wide range of materials can be possible, including : III-V compounds (GaN, AlGaN, AlN), Silicon, SiC, ZnO, ZnMgo, Oxides (SiO2, Si3N4), Polymers (PMMA, Photoresist), Metals (Al, Au, Ni, Pt, Ti, Ge, Mo), and Hard Materials (Al2O3, Glasses, Quartz, Sapphire).

Collaboration: A new tool to support CRHEA's research programs, open to the community.
Contact : Sébastien Chenot _ sc@crhea.cnrs.fr

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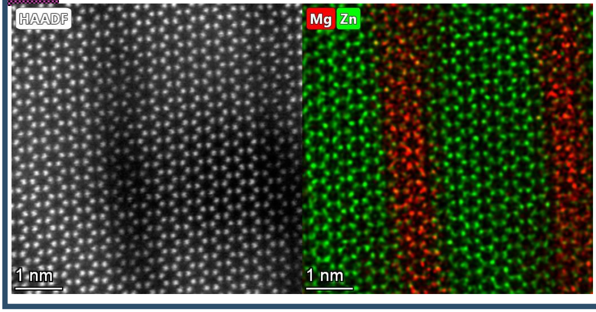

Fig 1: High resolution high angle annular dark field image of a ZnMgO/ZnO superlattice with its corresponding chemical map using energy dispersive X-Ray spectroscopy. These experiments have been realized with a Thermo Fisher Spectra 200 STEM. Sample preparation by Nolwen Le Biavan.

Seeing and analysing at atomic scale

Structural and chemical characterizations of materials down to atomic scale become essential to the understanding of the fundamental mechanisms governing their modes of formation and their properties of use. 7 academic labs and 2 companies from different areas of research (semiconductors, metallurgy, , mineralogy, archeology…), led by CRHEA, have conducted the ACT-M (advanced characterization technics for materials) project for the acquisition of a scanning transmission electron microscope (STEM). Thanks to CNRS, Côte d'Azur University (UCA), région Sud, IMRA Europe company and European funding's, a Thermo Fishers Spectra 200 has been ordered. It will be installed summer 2021. This STEM will be fitted with a probe corrector resulting to a spatial resolution of 70pm allowing atomic scale imaging. Highly sensitive energy dispersive X-Ray spectroscopy will be possible thanks two large detectors (solid angle 1.8sr). A nanobeam electron diffraction module completes the configuration for phase and orientation mapping

ACT-M STEM, at the cutting edge of technology, will allow researchers and engineers from UCA area and further to compete in the very challenging field of material research.

Breakthroughs

A new state-of-the art scanning electron microscope with atomic resolution capabilities has been acquired.

Perspectives

The installation of the ACT-M STEM in summer 2021 will open a very exciting time with atomic scale studies of a large panel of materials.

Collaborations : CEMEF, INPHYNI, CCMA, CEPAM, LAGRANGE, GEOAZUR, IMRA Europe, SGL
Contact : Philippe Vénnéguès _ pv@crhea.cnrs.fr

PhD: defense of Victor Fan Arcara

Victor Fan Arcara defended his PhD work on "Tunnel junctions in nitride heterostructures for LED applications".
The defense took place in the amphitheater of CRHEA March 10th 2020.

HDR: defense of Benjamin Damilano

Benjamin Damilano defended his Habilitation à diriger les Recherches (HDR) by presenting his work on "Multicolored light emitting diodes based on (Ga, In)N".
The defense took place in the amphitheater of CRHEA on October 08th 2020.

PhD: defense of Nadia El Bondry

Nadia El Bondry defended his PhD work on "Epitaxy of innovative heterostructures for high frequency GaN HEMTs ».

The defense took place online December 08th 2020.

PhD: defense of Rajath Sawant

Rajath Sawant defended his PhD work on "Dielectric phase gradient metasurfaces for classical and quantum optics applications." The defense took place in the amphitheater of CRHEA December, 15th 2020.

Arrival: Hélène ROTELLA

Hired as CNRS research associate.

Advancement / Prize

Yvon Cordier
First class senior research associate.

Jesus Zuniga-Perez
Senior research associate.

Christiane Deparis
Outstanding research associate.

Philippe De Mierry
Outstanding research associate.

Eric Frayssinet
First class research engineer.

Noureddine Slama
Assistant engineer.

1st EDSFA thesis prize for Nolwenn Le Biavan (12/2020)

This work was carried out within the framework of the ZOTERAC european project coordinated by CRHEA. This thesis was defended on 13/11/2019. They focus was on the growth and characterization of ZnO / (Zn, Mg) O heterostructures which are at the heart of components called quantum cascade lasers and enabled the first demonstration of an emitter in the THz at room temperature.

- 61 researchers, professors, engineers, PhDs and post-docs
- 4,5 M€ annual budget without salaries
- 41 publications in 2020
- 50 patents
- 6 European projects (1 ERC - 1ERC POC) and 17 ongoing ANR projects
- Coordination of one laboratory of excellence

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