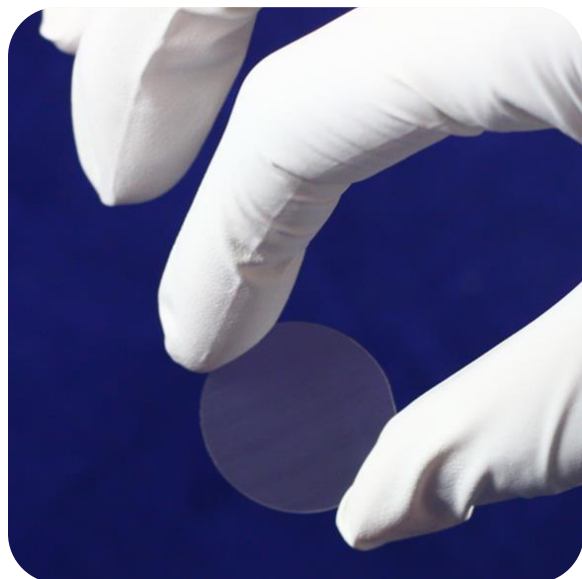
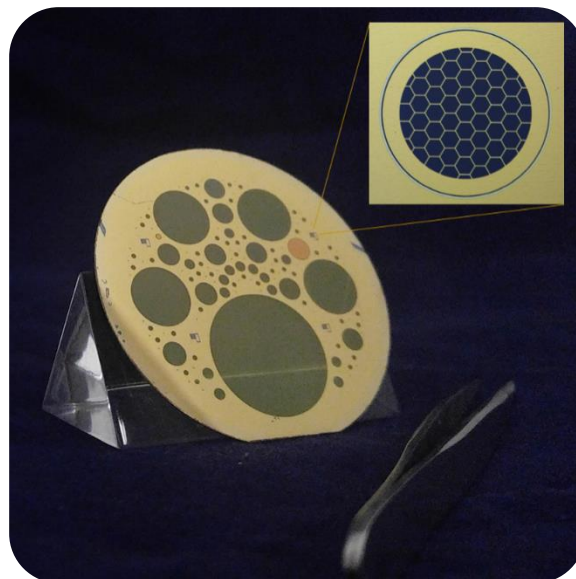




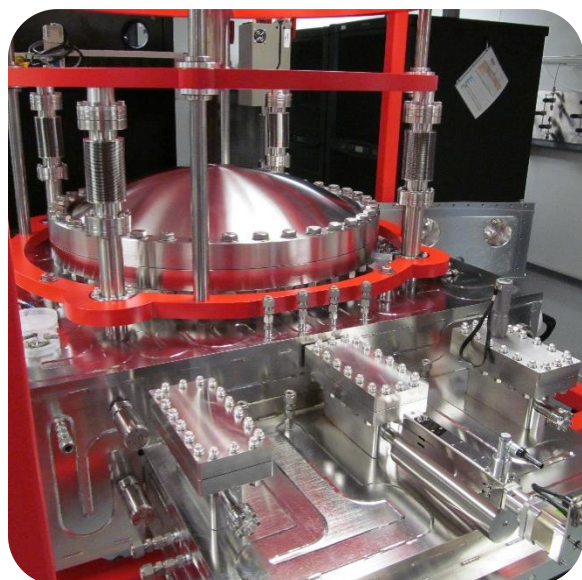
## Next Generation Wide & Ultrawide Bandgap Semiconductor Technologies



Crystalline Substrates



Semiconductor Devices



Crystal Growth  
Equipment



Large Area Templates

## Technical Core Competencies

- Vapor Phase Crystal Growth Process Modeling & Simulation
- Vapor Phase Crystal Growth Equipment Design & Fabrication
- Crystalline Materials Growth & Fabrication
- Crystalline Materials Characterization
- Semiconductor Device Design & Fabrication
- Semiconductor Device Test & Evaluation

## Products & Services

### Advanced Crystal Growth Equipment

- KVPE™ Hydride Vapor Phase Epitaxy Growth System for GaN and Ga<sub>2</sub>O<sub>3</sub>
- KPVD™ Plasma Vapor Deposition Growth System for AlN & Other Materials
- External Metal-Halide Sources
- Custom Crystal Growth Systems & Components

### Advanced Crystalline Materials

- GaN & Related III-N Materials
- Ga<sub>2</sub>O<sub>3</sub> & Related III<sub>2</sub>O<sub>3</sub> Materials
- Graphene & Related Materials
- Crystalline Cu & Related Materials

*Kyma owns or licenses >30 patents mostly covering the growth and fabrication of III-N materials & devices but also diamond coated wire and electromagnetic field sensor technology.*

### Advanced Semiconductor Devices

- Vertical GaN Photoconductive Semiconductor Switch (PCSS)
- Lateral GaN PCSS
- GaN FINFET

### Advanced Engineering Services

- Crystal Growth Process Modeling
- Device Performance Modeling
- Specialty Parts Manufacturing
- Wafer Fabrication & Reclaim



# Federal Contract Supported New Products in Development

## GaN-on-Diamond Templates

- For Improved Thermal Impedance for Advanced GaN Electronics
- Direct GaN Growth on Polycrystalline Diamond with Novel Buffer
- Supported by Navy under Contract No. N00178-17-C-0004

## High Power & Speed Photoconductive Semiconductor Switch (PCSS) Devices

- Many Applications Beckon and Phase I will Identify Potential Early Adopters
- Leveraging Kyma's KO-GaN™ & KO-Switch™ Technologies
- Supported by Air Force under Contract No. FA3002-19-P-A006

## Large Area GaN Substrates from Engineered Seeds

- For Low Cost High Performance Vertical Power Electronics
- Leveraging Kyma HVPE Growth Technology & Qromis' Engineered Seeds
- Supported by Navy under Contract No. N68335-18-C-0332

## Large Area AlGaN Substrates from Engineered Seeds

- For Next Generation AlGaN Device Development
- Leveraging Kyma HVPE Growth Technology & Qromis' Engineered Seeds
- Supported by Air Force under Contract No. FA8650-18-C-5040

## Gallium Oxide Epiwafers for Vertical Power Electronics

- For Development of 20kV+ Power Electronics
- Leveraging Kyma HVPE Growth Technology for Thick Epiwafer Growth
- Supported by Air Force under Contract No. FA9550-17-P-0012

## Large Area Electronic Grade Diamond Wafers

- For Development of Diamond Based RF & Power Switching Devices
- Leveraging Kyma's Seed Preparation Technology
- Michigan State University is Diamond Crystal Growth Partner
- Supported by Army under Contract No. W911QX-18-C-0005

## Kyma's Two Facilities in the Research Triangle Region

### Kyma Headquarters & Crystal Growth & Characterization Facility (8,000 ft<sup>2</sup>)

- 8829 Midway West Road, Raleigh, NC 27617

### Kyma Materials Fabrication & Device Test Facility (5,000 ft<sup>2</sup>)

- 8801 Midway West Road, Raleigh, NC 27617

## Recent News Featuring Kyma's Technologies

- *Gallium oxide substrates*, Semiconductor Engineering Manufacturing Bits 13 Mar 2018, <https://semiengineering.com/manufacturing-bits-march-13/>
- *Kyma Demos 100mm Free-Standing GaN With Qromis*, Compound Semiconductor Magazine, 13 Nov 2017, [https://compoundsemiconductor.net/article/102899/Kyma Demos 100mm Free-Standing GaN with Qromis](https://compoundsemiconductor.net/article/102899/Kyma_Demos_100mm_Free-Standing_GaN_with_Qromis)
- *Kyma demos 200mm GaN HVPE on QROMIS' MOCVD GaN-on-QST wafers*, Semiconductor Today, 6 Nov 2017, [http://www.semiconductor-today.com/news\\_items/2017/nov/kyma\\_061117.shtml](http://www.semiconductor-today.com/news_items/2017/nov/kyma_061117.shtml)

## Recent Scientific Publications Featuring Kyma's Technologies

- *Growth of 50mm Beta-Gallium Oxide ( $\beta$ -Ga<sub>2</sub>O<sub>3</sub>) Substrates*, J.D. Blevins et al., CS MANTECH 2018; <http://csmantech2018.conferencespot.org/program>
- *Ultrawide-Bandgap Semiconductors: Research Opportunities and Challenges*, J.Y. Tsao et al., <https://doi.org/10.1002/aelm.201600501>
- *Next-Generation Photomultiplier Detectors Using Transmissive III-Nitride Semiconductor Electrodes*, R. Buckles & K. Sun, <https://www.lanl.gov/projects/ldrd-tri-lab/assets/docs/FY17-nnss-annual-report.pdf>
- *GaN-on-silicon high-electron-mobility transistor technology with ultra-low leakage up to 3000V using local substrate removal and AlN ultra-wide bandgap*, E. Dogmus et al., <http://iopscience.iop.org/article/10.7567/APEX.11.034102>