Roll-to-roll manufacturing of large-area GaN sheets for photonics applications

Vladimir Matias, Ph.D.
Founder and President
Imagine a Display:

- That has better color gamut than possible with displays today
- That is >10x more power efficient than an LCD
- That is super bright (>100,000 nits)
- That is paper-thin
- That is ultra flexible
- That is extremely fast and robust
This can be done with a *thin sheet of opto-semiconductor*

- Today’s GaN-based LEDs are unparalleled sources of bright and efficient light
- *Monolithically* integrate LEDs, transistors, sensors in a sheet
- Creates a new paradigm for displays
Problem – Not possible up until now

- Need epi-GaN devices *in large areas* –
  today’s GaN LEDs are made on 6” sapphire wafers

- Need epi-GaN devices *at low cost* –
  today’s epi-GaN costs $2-3/cm²

- Need a *flexible and robust substrate* –
  today’s LED substrates are rigid wafers

© iBeam Materials Proprietary | 4
iBeam's Breakthrough: High-quality LEDs on a Metal

- *First-in-the-world Epitaxial InGaN LEDs fabricated* directly on polycrystalline metal foil (no transfer)
- Single-crystal templates of large-area substrates such as metal, glass and ceramics, replace single-crystal wafers - **GANOX**
- Fundamentally transforms how LEDs are *manufactured and used*
GANOX Enables GaN Devices in Large Areas

InGaN LEDs on a metal foil

- 50 µm Parallel Arrays
- LED Structure
- 100 nm
- TDD 6.0x10^8 cm^-2
- GaN-on-Metal Threading Dislocation Densities (TDD): mid to high 10^8/cm^2 (similar to GaN on sapphire)

GaN/AlGaN HEMT on a metal foil

- 25 nm epi-AlGaN barrier
- 3 µm undoped epi-GaN buffer
- IBeam IBAD stack – 250 nm
- Metal Foil Substrate 60 µm

Copyright © 2022 iBeam Materials, Inc. All rights reserved. Proprietary
GANOX Enables Manufacturing in Large Areas

- Only by depositing in large-areas is true scaling possible
- Ultimate scaling: kilometer lengths are possible via roll-to-roll (>10,000x)
- Cost reduction > 20x possible
GANOX Enables Large-Scale Monolithic Integration of LEDs

**Electronics**
- Vacuum tube
- Transistor
- Large-scale Integrated circuit

**Photonics**
- Light bulb
- LED
- Large-area and large-scale integrated LED sheets

Materials Proprietary | © iBeam Materials Proprietary
Company

iBeam incorporated in 2011
Non-dilutive funding to date $6M, Investment $2M
Partnering is a strategic component of our go-to-market plans. Samsung is our first strategic partner.

Board of Directors

Vladimir Matias, PhD
Founder and President
Leding world expert in IBAD crystal alignment technology

Julian Osinski, PhD
VP Product Technology
25+ years in semiconductor industry, device and QD applications expert

Klaus Kunze, PhD
Director Chemical Technology
25+ years in materials/chemical coatings industry; expert in solution coating, >130 patents.

Michael Pachos, MBA
iBeam Board Director
Managing Director at Samsung Ventures; Focus on Consumer, Display, and IT related investments

Mike Krames, PhD
iBeam Board Director
Renowned expert in LED technology, Former Soraa CTO, Lumileds EVP, Head of HP Advanced Labs, advises iBeam on LED technology
iBeam’s Breakthrough: LEDs, FETs on Flexible Metal Foil

Achievements:

2016
First-in-the-world
InGaN LEDs directly on metal foil

2017
iBeam’s two fundamental patents are issued

2018
Arrays of microLEDs on a flexible metal substrate

2019
First-in-the-world
GaN transistors on metal foil

2020
Two partner JDAs
Samsung Repeat Investment

Next Step
Achieve milestones for scalable low-cost manufacturing process
GANOX Technology for Monolithic MicroLED Display

- **Monolithic integration** of LEDs for μLED displays with NO TRANSFER
- Yield and Reliability improve greatly compared to mass transfer approaches
- Overlayed TFTs or epi-integrated GaN transistors to control LEDs
- QD downconversion for red and green colors, easily exceeding DCI-P3 gamut
- **Paper thin and flexible substrate**
Evolution of Information Displays: Future in 3D

Future Light-field displays will require billions of subpixels, making transfer impossible. Monolithic Integration becomes the only practical solution.
GANOX Disrupts MicroLEDs

✧ iBeam has a radically new LED technology using large-area metal foil:
  • High-quality LEDs and FETs demonstrated
  • Extreme-volume production scale up possible
  • Enables new product categories for wearables and mobile devices

✧ Monolithic integration of LEDs and GaN switching devices in large areas are a new approach for flexible super-bright paper-thin microLED displays
iBeam Materials

➢ Breakthrough disruptive LED platform
➢ Seeking key strategic partners and investors

Vladimir Matias
Founder & President
iBeam Materials
2778A Agua Fria St.
Santa Fe, NM 87507

www.ibeammaterials.com
vlado@ibeammaterials.com
+1-505-577-3193

First-in-the-world LEDs on metal foil
THANK YOU

Questions?