New Manufacturing Methods for Light Shaping

DOE R&D Conference, 2017
Long Beach, CA
Outline

• Introduction to Luminit
• Refractive Optics – Light Shaping Diffusers
  • Roll-to-Roll (and -Sheet) Manufacturing
  • Injection Molding - Flat and Curved
• Diffractive Optics – CGH & HOE
• Conclusions
Luminit’s Background

Founded in 2006, Luminit is a global provider of innovative light management solutions for the lighting, display, automotive, aerospace, biomedical, and machine vision industries.

- Privately held, profitable small business
- 70 employees, U.S. manufacturing
  - Experiencing rapid growth in the next 12 months!
- Diversity in both customers and market segments
- Differentiated high performance products
First Application of Holography to Lighting and Displays

Light Shaping Diffusers (LSD)

Mimic Diffuser Function with Surface Relief

Holographic Recording:
- Creates pseudo-random pattern
- Can be symmetrical or asymmetrical

Surface Relief:
- No loss from scattering sites
- No particles = no wavelength dependence
Commercial Products

Surface Relief Components:
• Light Shaping Diffusers®
• Round Tip Display Film
• Direction Turning Film
• Edge-lit Uniformity Tape
• Custom Prismatic Films
• Monolithic Glass LSD
• Crystal Screens
• Volumetric LSD

Available in Diverse Form Factors:
• Film
• Rigid Flats
• Plastic
• Sol-gel
• Glass
• Tape
• Injection Molded
• Curved IM

Largest market is LED lighting – Shaping Light As Needed!
Holography and LSD is Pervasive
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LSD is Manufactured Roll-to-Roll

- Shipping >100k R2R linear ft/month
- Class 100 operation
- Existing US manufacturing facility
- UV embossing process
- Holographic mastering

Ideal for Large Area, Flexible, and Uniform Products
LSD is Manufactured Roll-to-Sheet

- 10,000 rigid panels/month capacity
- Existing US manufacturing facility
- Similar UV embossing process
- Similar holographic mastering process

Enables Rigid Parts without Additional Lamination Process
LSD is Manufactured by Injection Molding

- Leverages existing infrastructure in Asia
- Similar holographic mastering process
- Eliminates UV embossing
- Monolithic part – PC, Acrylic, Urethane

Enables Complex Parts, without Conversion Processes
Now Introducing Curved Injection Molding

- Complex holographic mastering
- All processes must be curved
- Same benefits of IM process, costs
- LSD can be inside or outside surface

Enables Automotive Market Monolithic Parts
How can we apply Light Shaping to LEDs?

- As secondary lens
- At package output?
- On phosphor layer?
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Computer Generated Holography (CGH)

CGH Example: Auto Welcome Mat Lighting
HOE for Augmented Reality

Transparent, thin, near-to-eye displays using DLP (above), OLED (below), or any other microdisplay technology.
HOE Mass Production

• HOE mass production capability worldwide is negligible today
• Luminit is currently ramping up capacity to meet AR industry’s needs
  • PP capacity (1,000-20,000 units/mo) in 1H17
  • MP capacity (1,000’s of m²/mo) in 2H17
• Luminit is only company with right-sized, roll-to-roll manufacturing capability, with needed holographic expertise to meet AR industry’s needs
Conclusions

• Light Shaping with designed refractive optics is already a critical part of the LED ecosystem

• For cost and efficiency reasons, Light Shaping will get pushed closer to the chip

• New manufacturing methods can help bring light shaping to LED chips and packages

• Luminit has the market position, balance sheet, personnel, manufacturing and technology to help meet these DOE goals.