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Patterned organic semiconductor layer for increased efficiency in OLEDs

A simple method to create a single-component diffraction grating using organic semiconductors for the improvement of outcoupling efficiency in OLEDs.

IP Status: Pending US Patent; **Application #:** 16/881,196

Periodic surface structures to improve light outcoupling

High-efficiency organic light-emitting diodes (OLEDs) are of interest for display and lighting applications. While current OLED technologies exhibit near 100% internal quantum efficiency, practical external quantum efficiencies remain between 25-30%. This is largely due to the low light outcoupling (the proportion of photons generated by the organic layer that escapes the device) as a result of significant mismatch between refractive indices of the various materials used in the OLED device. Currently available solutions to improve light outcoupling are either incompatible, too complex, or simply unsuitable to be implemented in the semiconductor manufacturing process.

Researchers at the University of Minnesota have developed a new method to create aligned, periodic surface structures (similar to diffraction gratings) using small-molecule organic semiconductors. Such wrinkle patterns formed using this method can potentially increase the light outcoupling efficiency by increasing forward-directed light without requiring changes to other semiconductor layers. These patterned layer(s) with millimeter-scale single-crystal domains can be directly integrated into existing semiconductor architecture using an annealing-based process change. This technology offers a high degree of control on the wavelength and depth of patterns that are useful for optoelectronic applications. Some of the key advantages of this technology includes:

- Large-area, single-component pattern coverage
- Tunable pattern wavelength: 900 nm to 2,400 nm
- Excellent thermal stability
- Technology implemented via a simple heating step

Phase of Development

Pattern formation demonstrated and feature properties characterized in four archetypical organic semiconductors, namely TPBi, α-NPD, BCBP and rubrene.

Key Benefits & Differentiators

- **Single-component, direct integration** into single layers of organic semiconductors
- **Easy implementation** into existing OLED manufacturing process
- **High degree of control** over pattern features by simple changes in processing conditions
- **Potential for increased efficiency**in existing OLEDs leading to either higher brightness or increased stability
- No capital intensive equipment changes or additions are anticipated

Applications

Technology ID

2019-068

Category

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Publications

Formation of aligned periodic patterns during the crystallization of organic semiconductor thin films.
Nature Materials volume 18, pages725–731(2019),

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