Photolithographic Patterning of Perovskite Materials and Devices Utilizing Dry Lift-Off

This technology offers a patterned perovskite photolithographically in micrometer resolution and is based on a dry lift-off process. This method avoids the dissolution of perovskites in polar solvents because a barrier layer on the substrate is formed, partially removed, and exposing a pattern layer.

What is the Problem?

Metal halide perovskites have recently successfully emerged in a wide variety of applications in solar cells, light-emitting diodes (LEDs), photodetectors and lasers. They stand out from other conventional semiconductor materials not only for their excellent optoelectronic properties, but also for their facile solution processability and widely tunable bandgap. In the last several years, along with the booming development of perovskite solar cells, much effort has also been devoted into light-emitting applications of perovskite materials. However, these studies are mainly focused on synthesis and device engineering. The development of patterning perovskite films, especially using lithographic methods, has been comparatively lacking and imperfect, and lithographically patterned perovskite micro-LED arrays have not been demonstrated. This difference is likely caused by the ionic nature of perovskite materials, which makes them tend to be dissolved in common polar solvents that are often used in high-resolution lithographic methods. There is a need for lithographic patterning of perovskites.

What is the Solution?

The solution is an approach to pattern perovskite photolithographically in micrometer resolution based on a dry lift-off process. No solvent is needed in this lift-off process, thus avoiding the dissolution problem of perovskite in common polar solvents. The optoelectronic properties of perovskite materials are preserved throughout the fabrication process. Based on this approach, red, green, and blue (RGB) single-color perovskite patterns can be fabricated with a minimum resolution of 10 um, in addition to multicolor perovskite patterns, which could be further applied in liquid crystal display (LCD) applications. This can enable perovskite micro-LED displays for the first time. The synthesis method includes forming a barrier layer on a substrate, removing a portion of the barrier layer to yield a patterned barrier layer and an exposed portion of the substrate within a hole in the patterned barrier layer, forming a first portion of a perovskite on the patterned barrier layer and a second portion of the perovskite on the exposed portion of the substrate, and removing the patterned barrier layer, thereby removing the first portion of the perovskite.

What Differentiates it from Solutions Available Today?

Technology ID

BDP 8701

Category

Selection of Available Technologies

Hardware/Optics/Photonics

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Lithographically patterned perovskite micro-LED arrays have not been demonstrated due to the dissolution problem of perovskites in polar solvents. This solution avoids the dissolution problem, enabling perovskite photolithographic patterning and micro-LED displays.

Patent Information:

US20230157144A1

References

1. Cheng Chang, Chen Zou, Mark Odendahl, and Lih Y. Lin(43952) , https://opg.optica.org/abstract.cfm?uri=cleo_si-2020-SF3F.7, CLEO: Science and Innovations