



TOWARDS PEROVSKITE LIGHT EMITTING DIODE (PeLED) DISPLAY

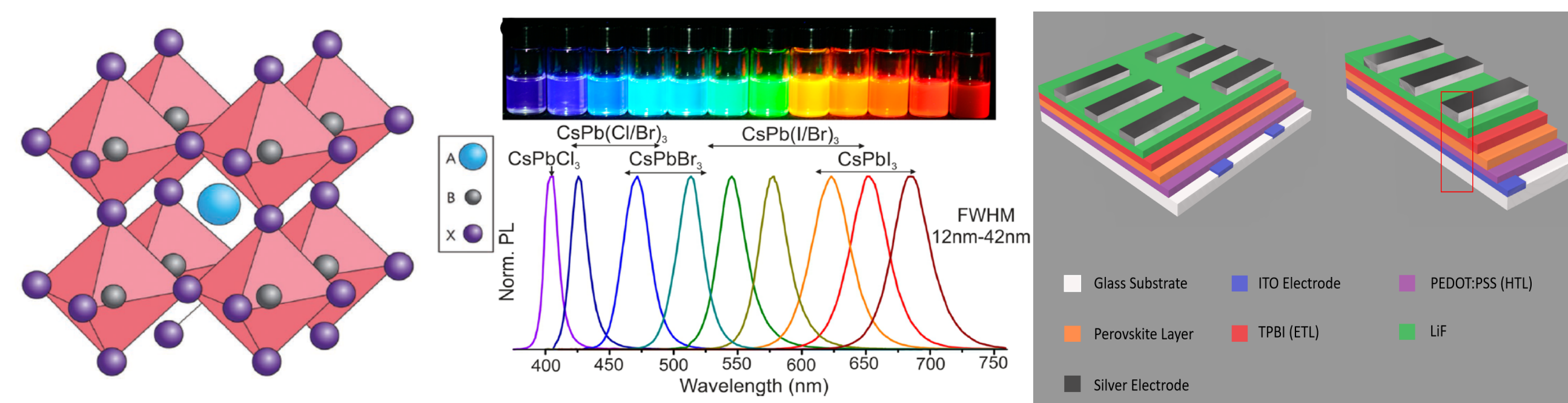
STUDENTS: CHENG CHANG, CHEN ZOU, MARK ODENDAHL

Introduction

- Perovskite is named after Russian mineralogist Lev Perovski. It was first referred to a calcium titanium oxide mineral, CaTiO_3 , and later applied to the class of compounds with a similar crystal structure, ABX_3 .
- Perovskite materials are highly promising solution-processable semiconductors for next-generation light-emitting applications.
- However, perovskites dissolve in most polar solvents, like water and lithographic developers, which makes perovskites not compatible with widely-used photolithographic processes which are necessary for device fabrications.
- Here we present a high-resolution, large-scale photolithographic method to pattern multicolor perovskite films, and work towards perovskite LED displays.

PeLED

- Perovskites show great potential as light-emitting materials because they have high photoluminescence efficiency, high color purity, high tolerance for defects, tunable bandgaps and low fabrication costs.
- Perovskite LEDs can be easily fabricated by spin coating and evaporation. The simple device structures and fabrication processes make it possible to integrate perovskite light source on silicon-based chips.
- A typical perovskite LED contains electrode, hole transporting layer (HTL), emission layer (EML), and electron transporting layer (ETL).

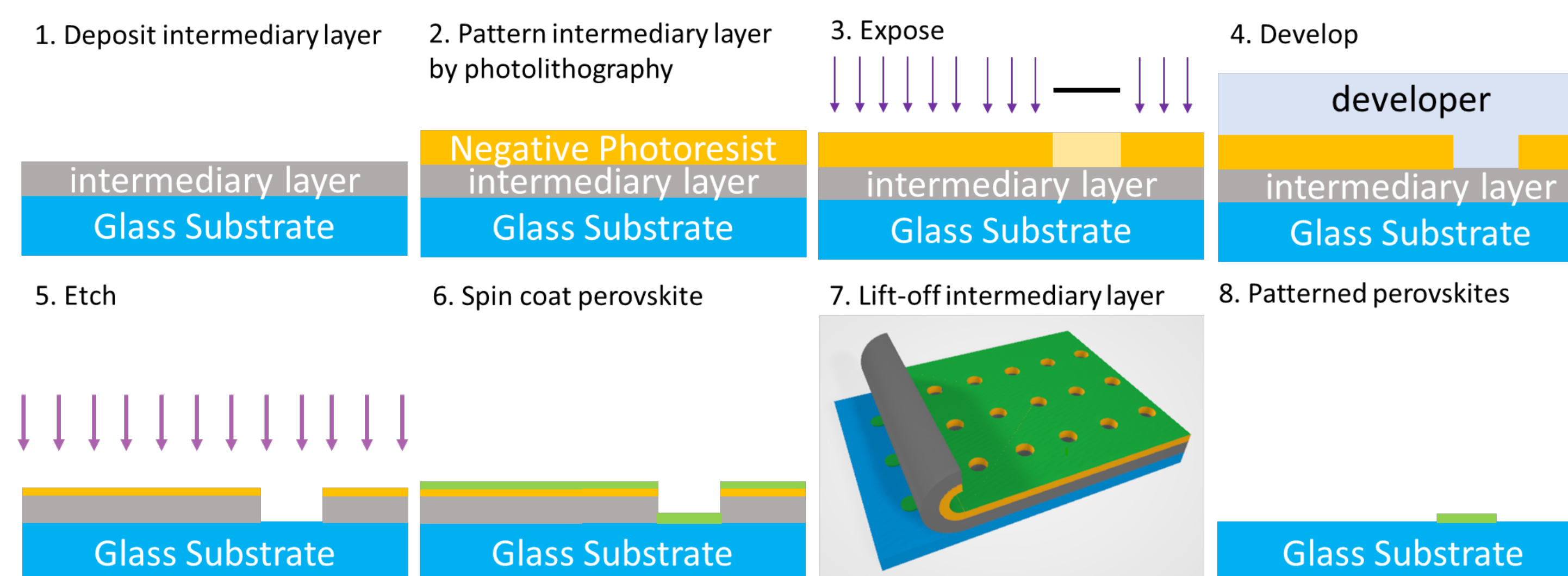


Quan, Li Na, et al. *Advanced Materials* (2018)

Protesescu, Loredana, et al. *Nano letters* (2015)

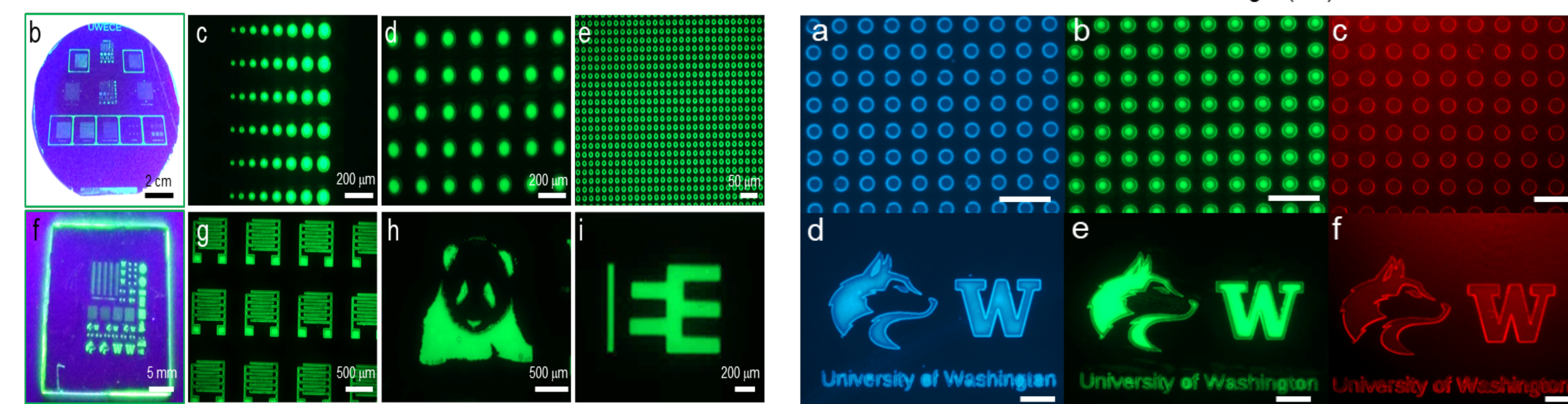
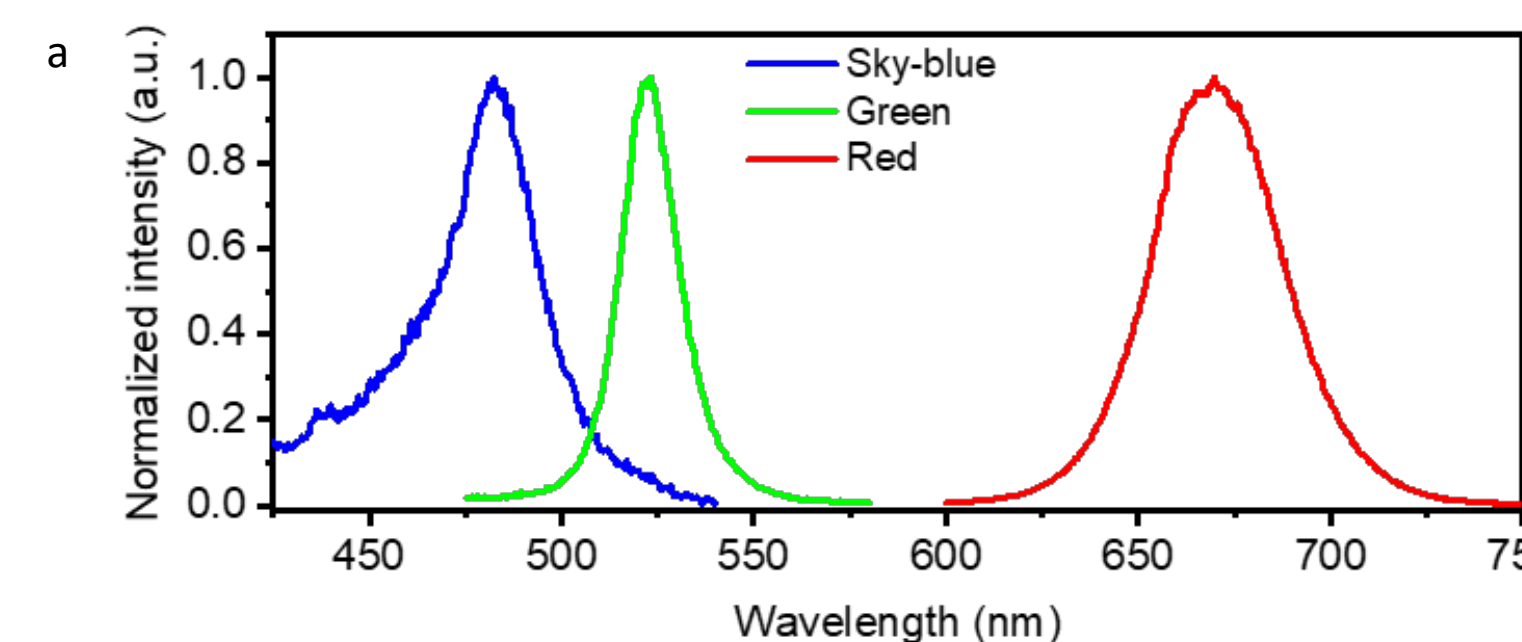
Patterned perovskite

- Perovskite materials are ionic, which makes them tend to be dissolved in common polar solvents that are often used in high-resolution lithographic methods.
- Possible solutions are: utilizing orthogonal lithography and sacrificial layers, dry etching, inject printing, and template-assisted growth.
- However, besides polar solvent, high heat, UV exposure and moisture during the patterning process will also affect perovskites performance.
- In our work, a dry patterning process is developed and applied.



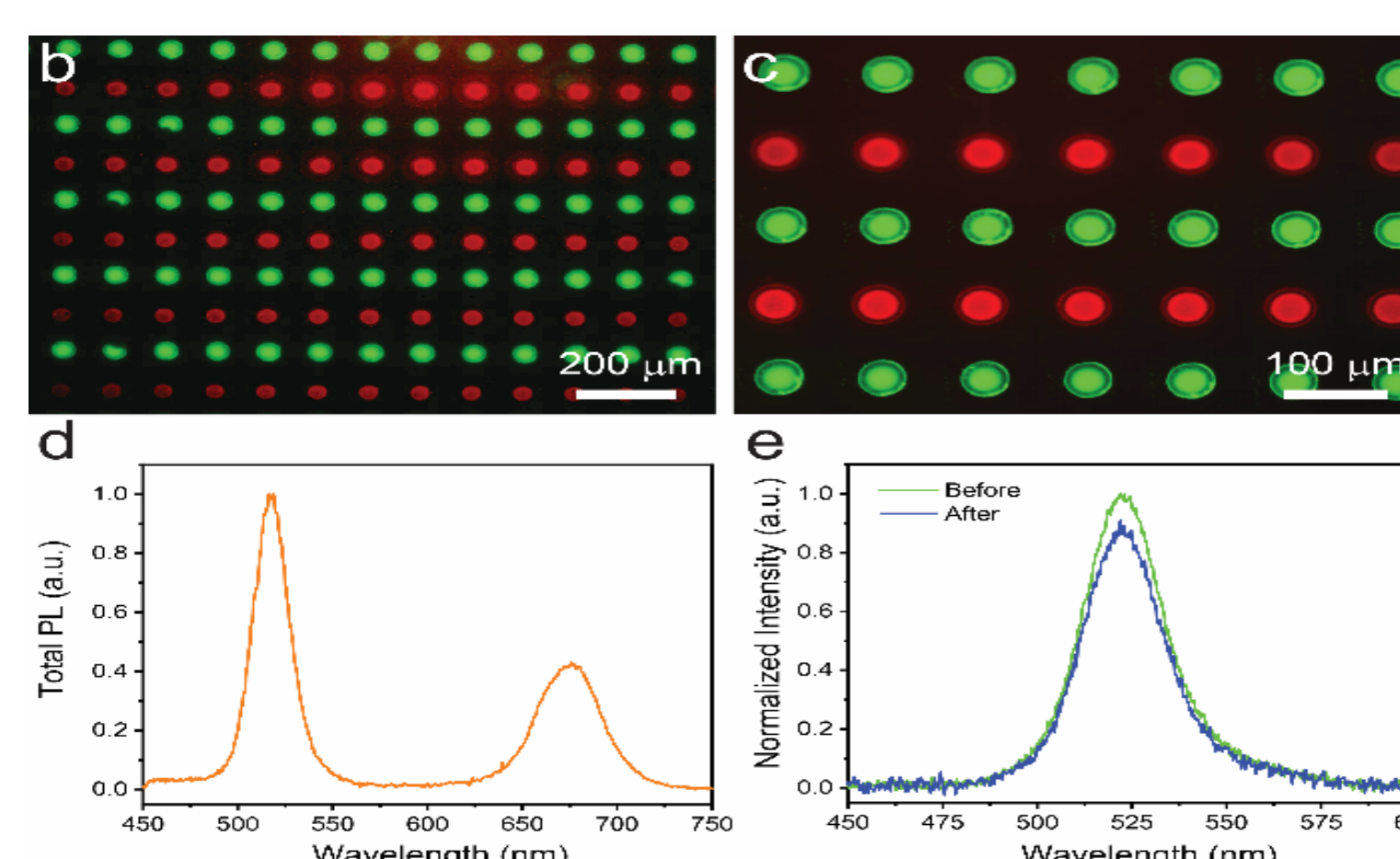
Single color perovskite patterns

- The bandgap of perovskite materials can be easily tuned by changing their chemical composition.
- Perovskites with different colors can be patterned by the same method.



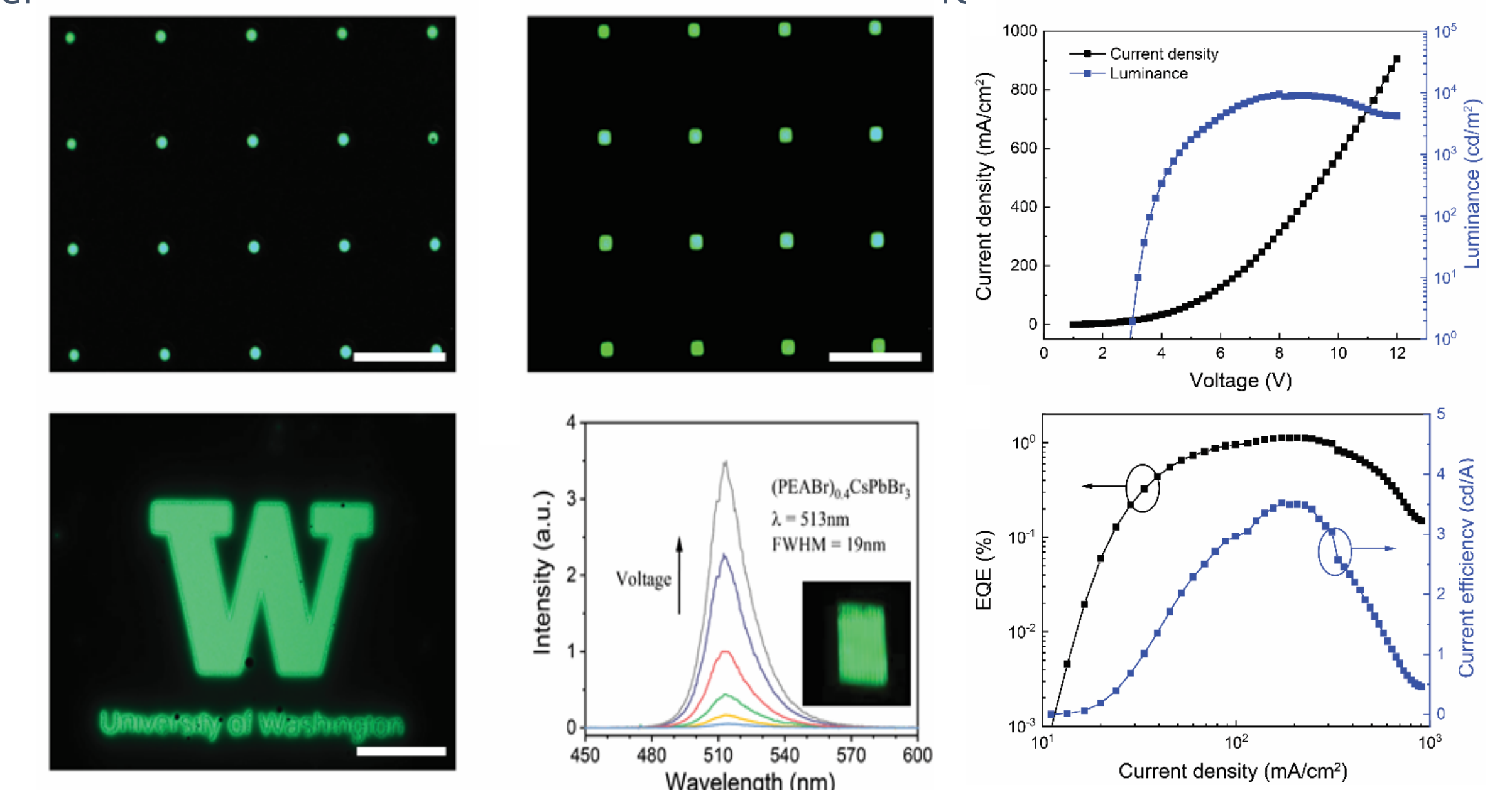
Multi-color perovskite patterns

- By repeating this method, multi-color patterns can be obtained.
- The intermediary layer also works as a protective layer, which will prevent perovskites from the moisture and polar solvent during fabrication.



Patterned perovskite LEDs

- Instead of only patterning perovskites, we can directly fabricate patterned perovskite LEDs.
- For a perovskite LED, its HTL, ETL and electrode can be patterned at the same time. After the patterning, LEDs performance is barely affected.



Towards perovskite micro-LED display

1. First layer patterned LED
2. Use intermediary layer to protect the first layer LED
3. Pattern resist
4. Pattern LED and do lift-off

