

Development of Black Pixel Define Layer with Half-Tone Spacer Structure for Stylus-Compatible Foldable OLED Displays

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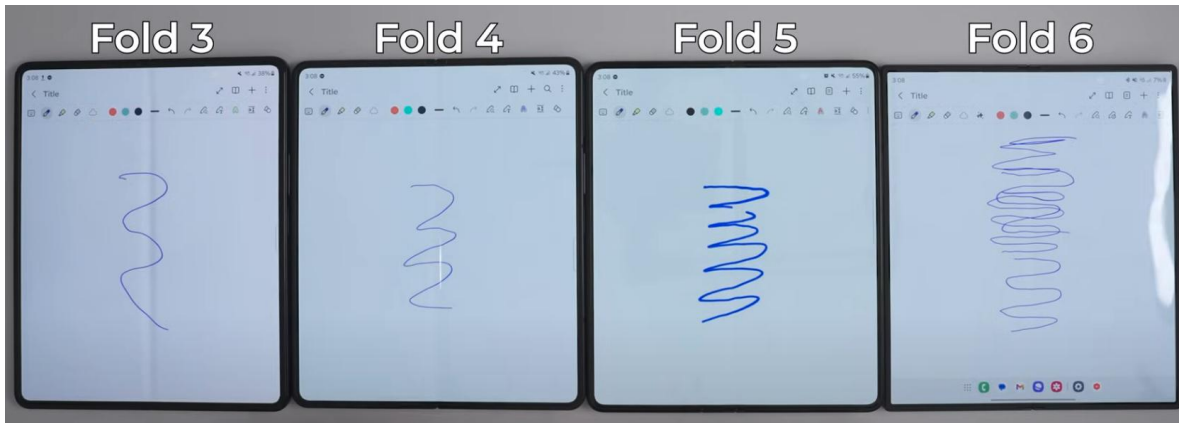
Samsung Display

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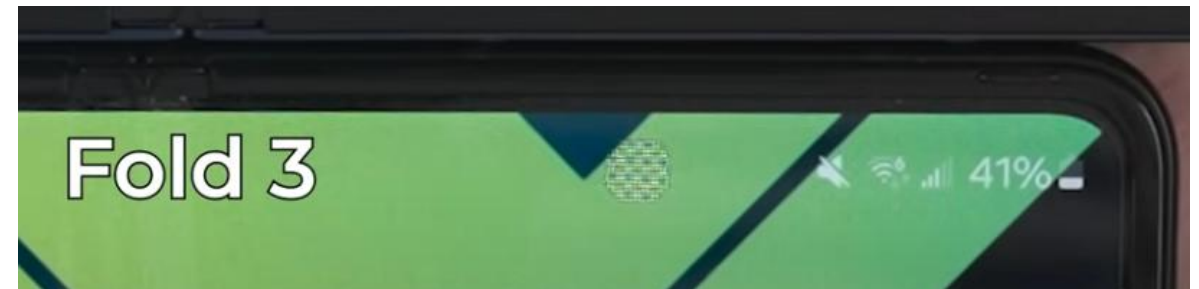
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1. Introduction

1. Galaxy Fold Series



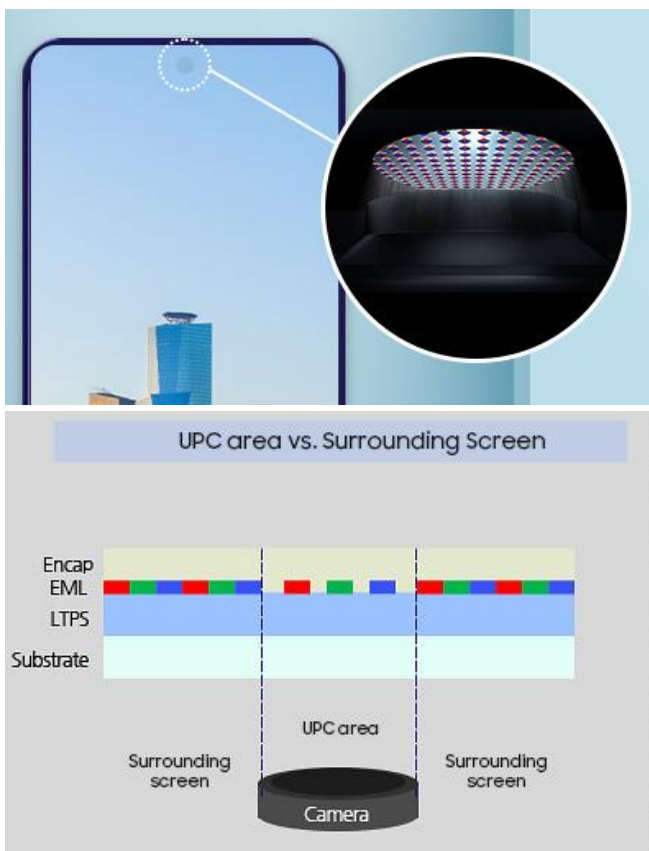
World 1st Foldable Display with Stylus Pen and without Polarizer



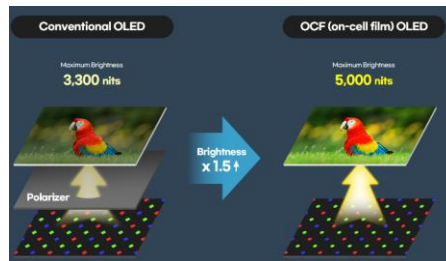
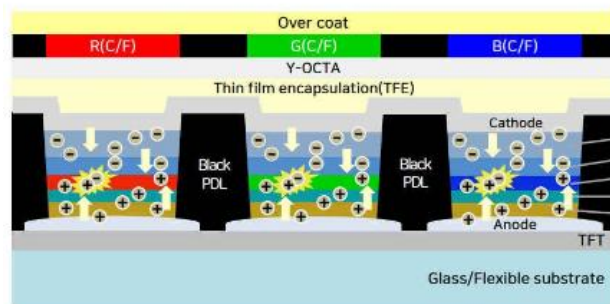
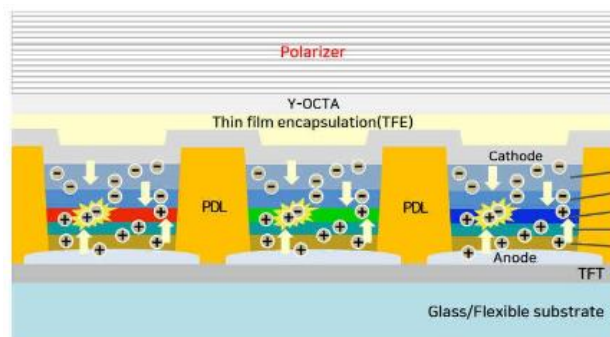
Source : https://youtu.be/qDXSiWSg7g?si=xS92VeeLlaUamNI_

2. Galaxy Fold 3

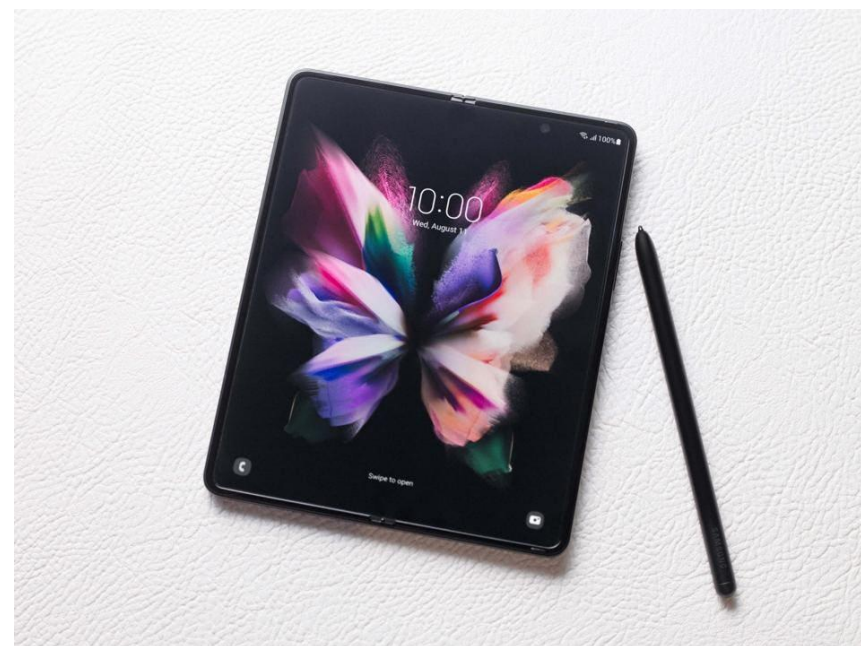
Under Display Camera



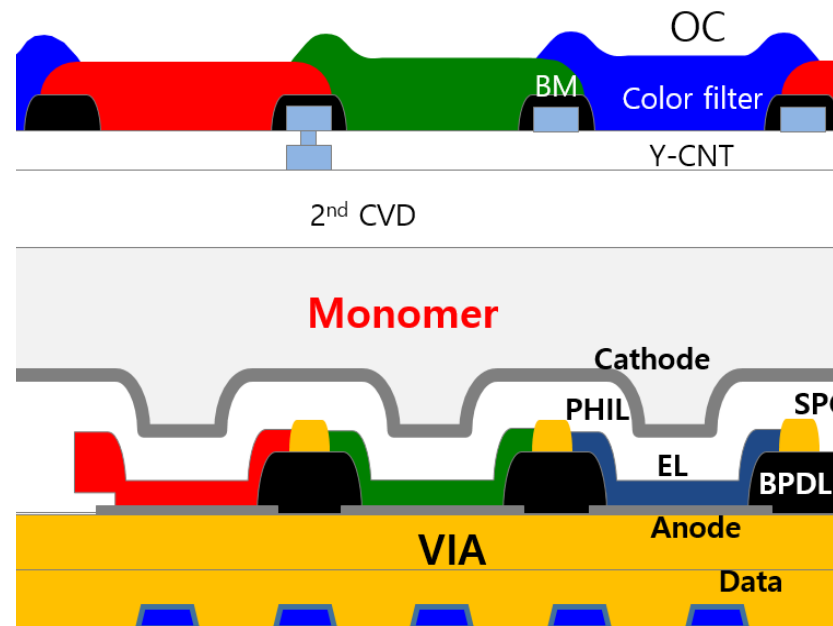
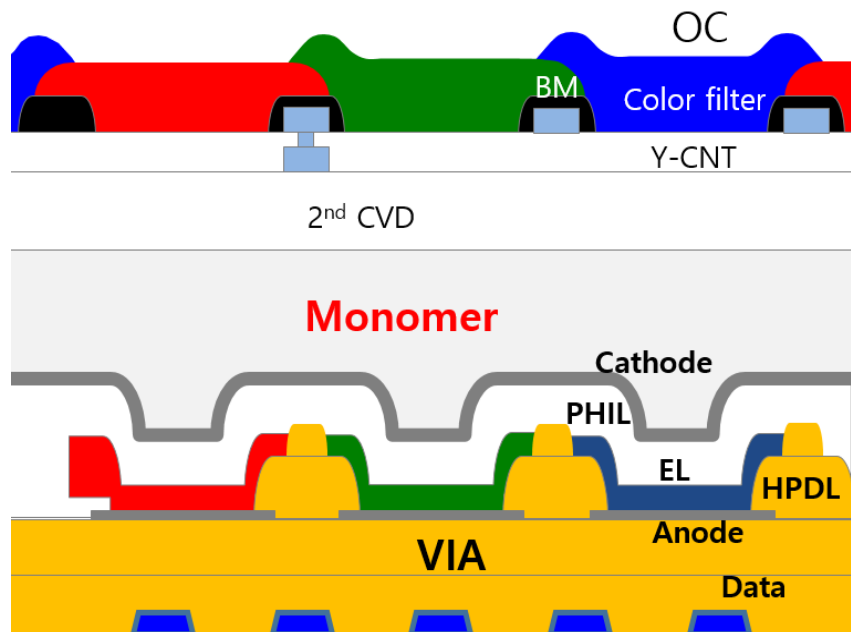
Polarizer Free (ECO² OLED™)



Stylus Pen

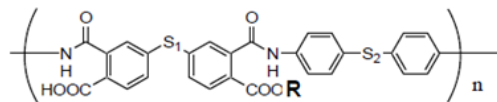


Description of Problem and Analysis

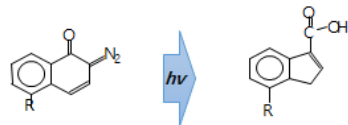


PSPI (Positive PR)

Binder Polymer



PAC



B-PDL (Negative PR)

Mill base

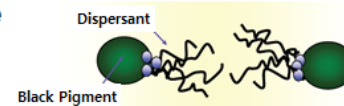
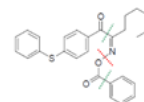
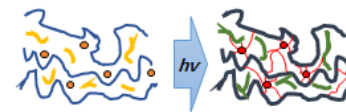


Photo initiator

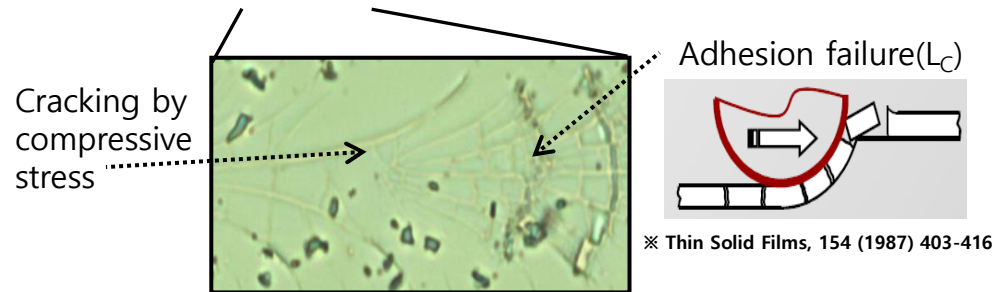
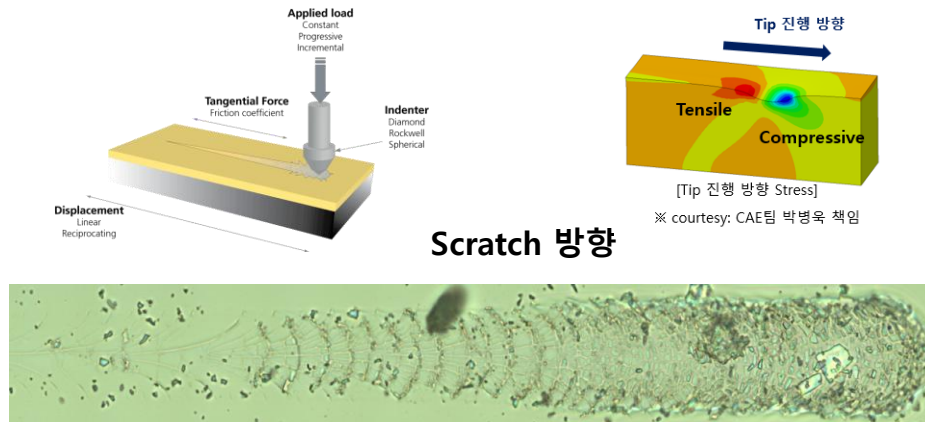


Monomer → radical polymerization



Description of Problem Phenomenon

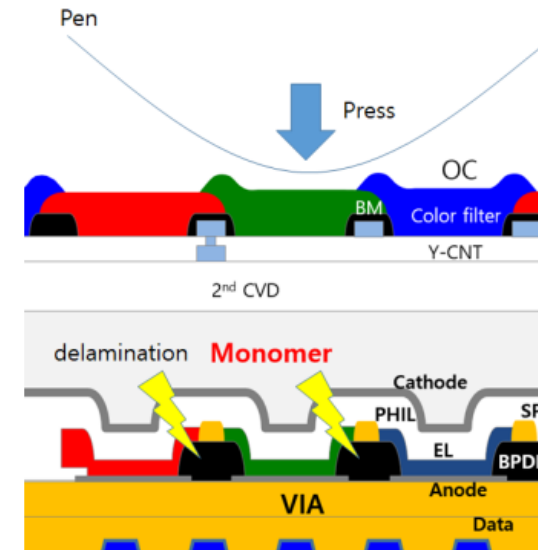
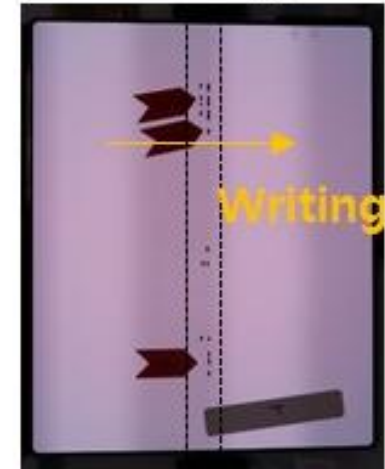
3. Scratch Test



<Hitting>

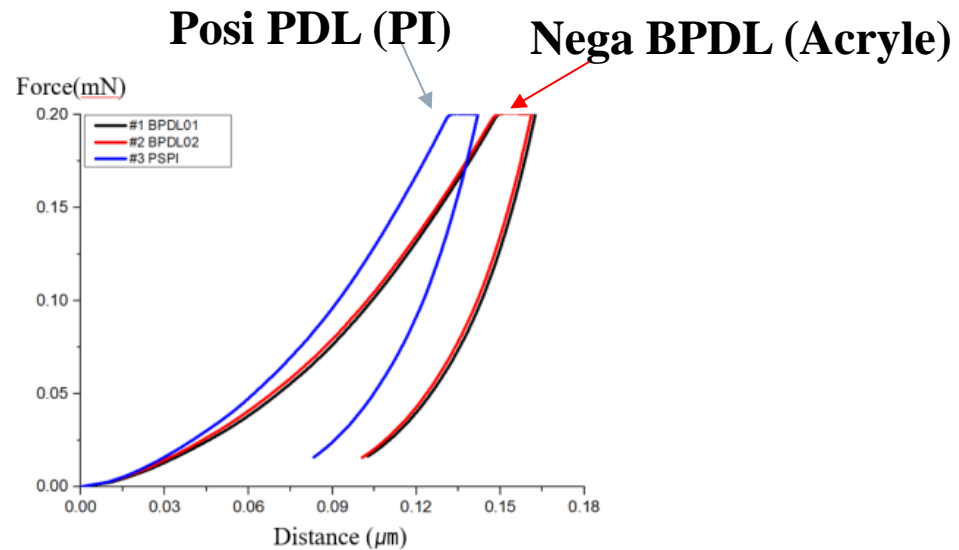
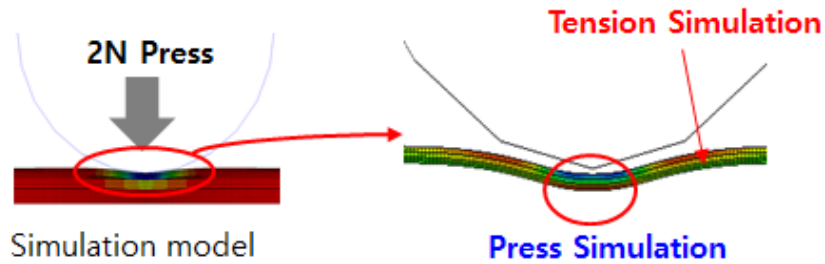


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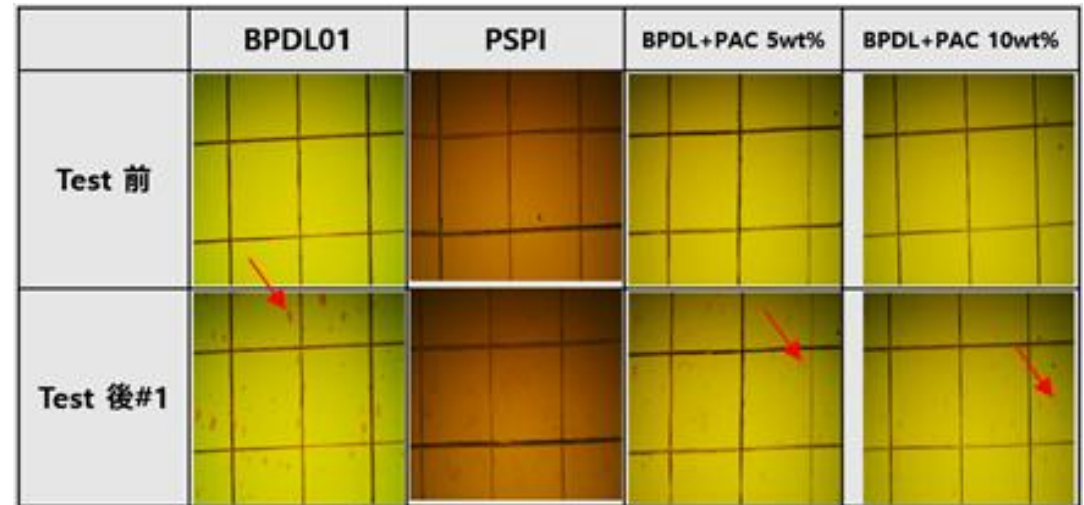
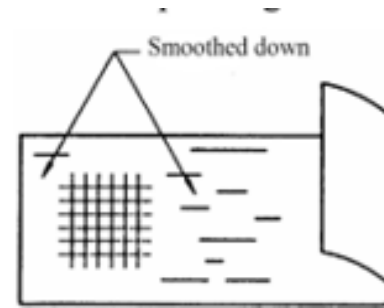


Hypothesis

1. Modulus Weakening → Pressure Distribution



2. Adhesion → Enhancing Adhesion Force

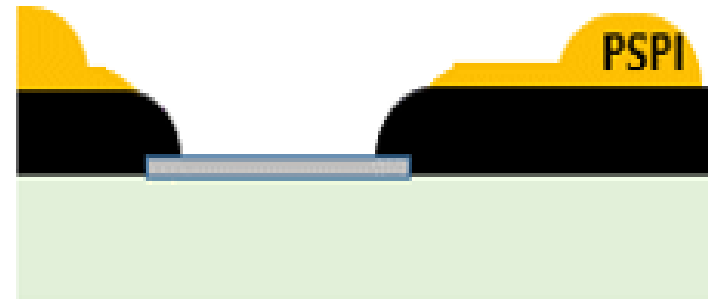
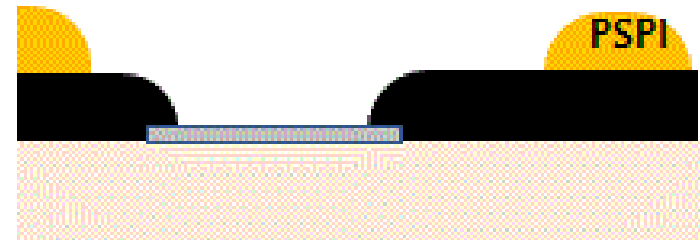


Breakthrough

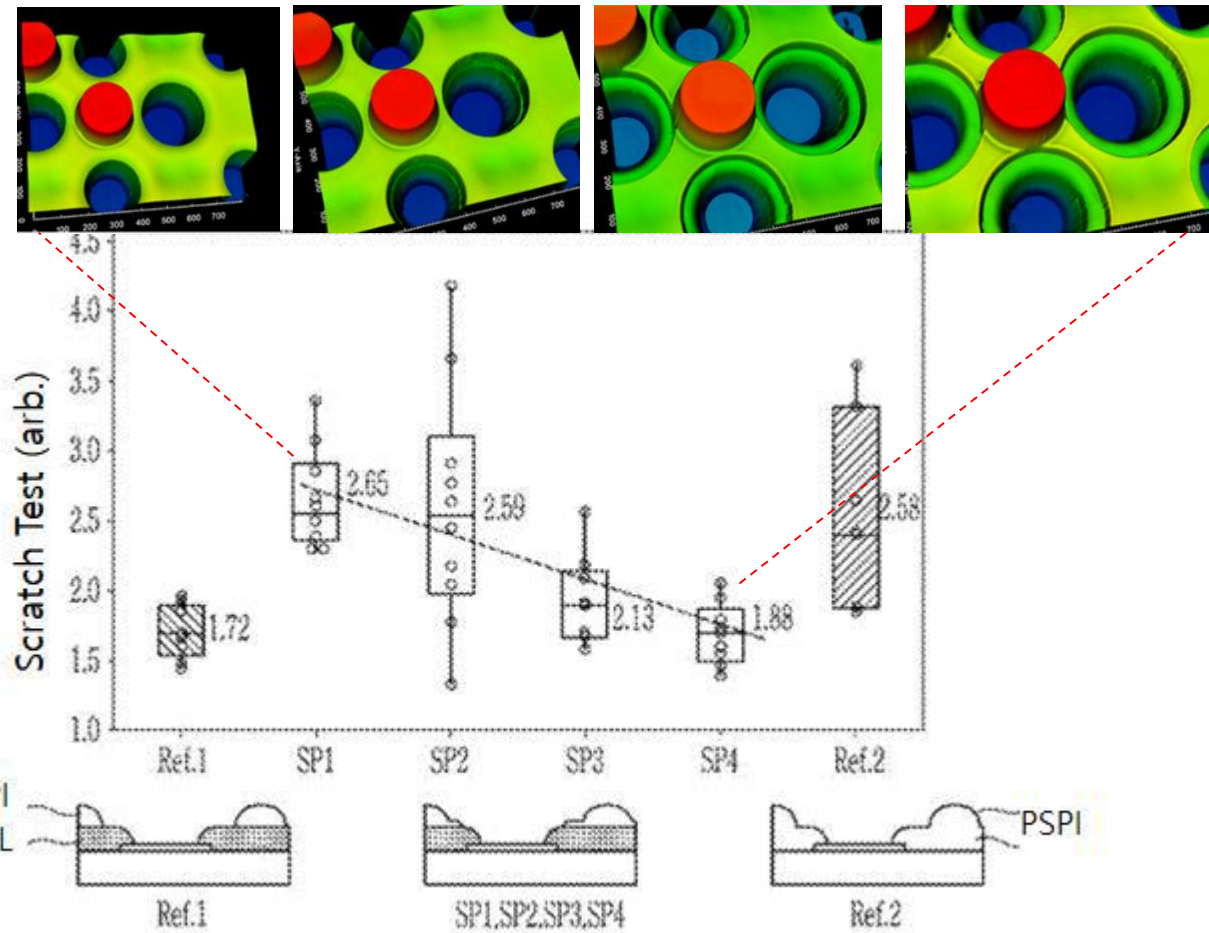
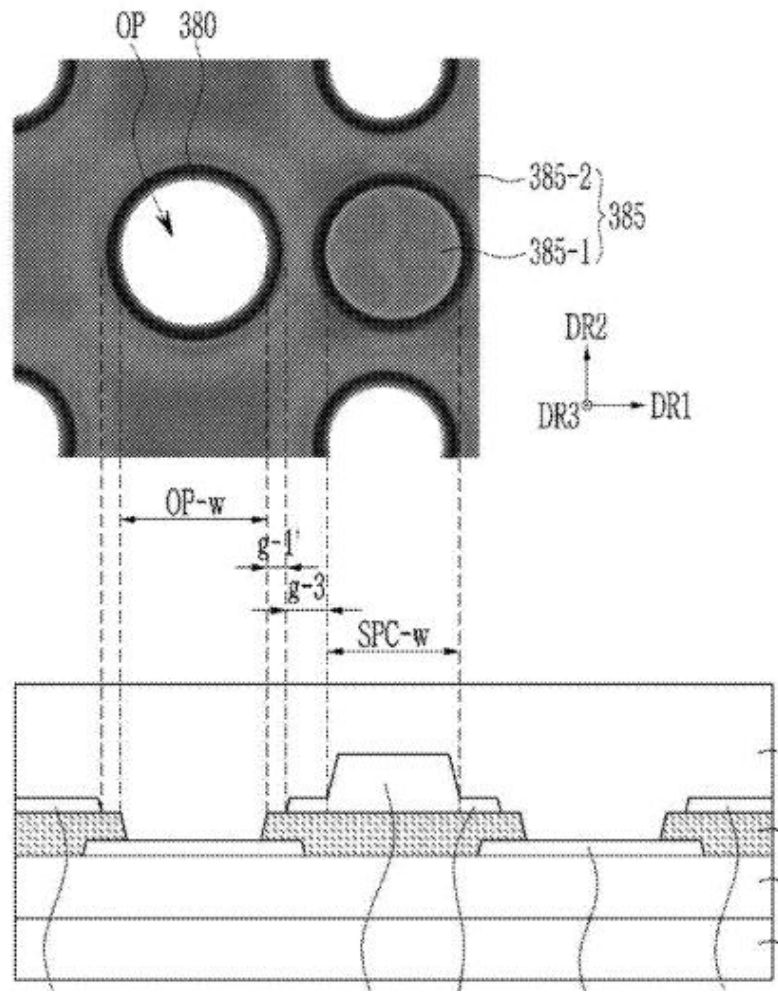
Idea ← Sugar Coated Donuts



Halftone Spacer Process

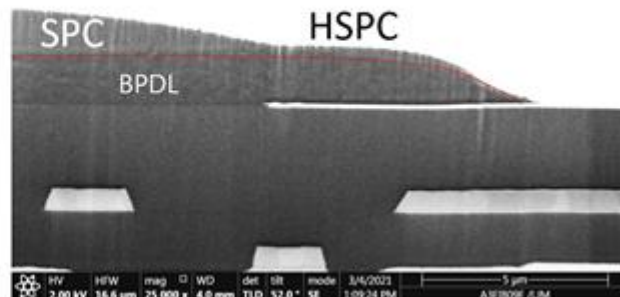
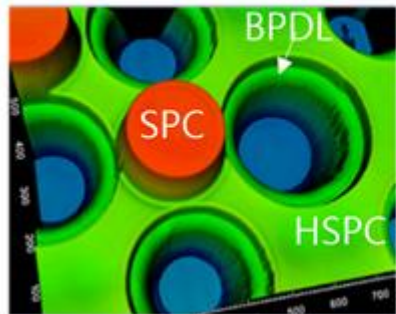
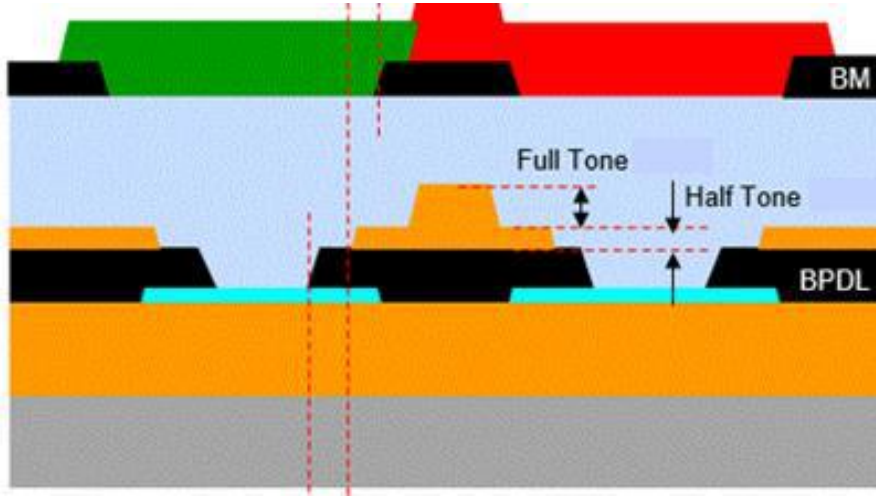


Experiments and Results



Source : US Patent 2022/0415979 A1

Discussion



Conclusion

- In order to create the world's first foldable display capable of using a stylus pen, we fundamentally studied the differences between polyimide-based organic films and acrylic-based black organic films to solve the problem.
- After discovering that Posi PR with organic deposition material and PAC has good adhesion, whereas Black PDL, which is Nega PR without PAC, has poor adhesion, a halftone spacer method was developed by coating Black PDL with Posi PR.
- We applied for a patent on the Half tone spacer on Black PDL structures and its product application. (KR,US,CN)
- This research played a very important role in expanding the foldable display market, and in the future, Samsung will strive to satisfy customers with various structures such as the Galaxy Flip and Galaxy Fold.

Thank you !