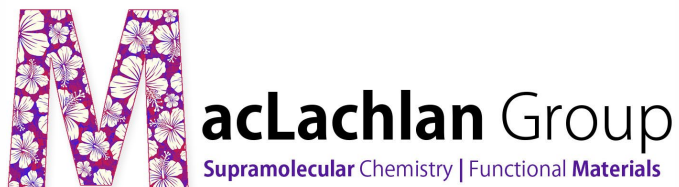


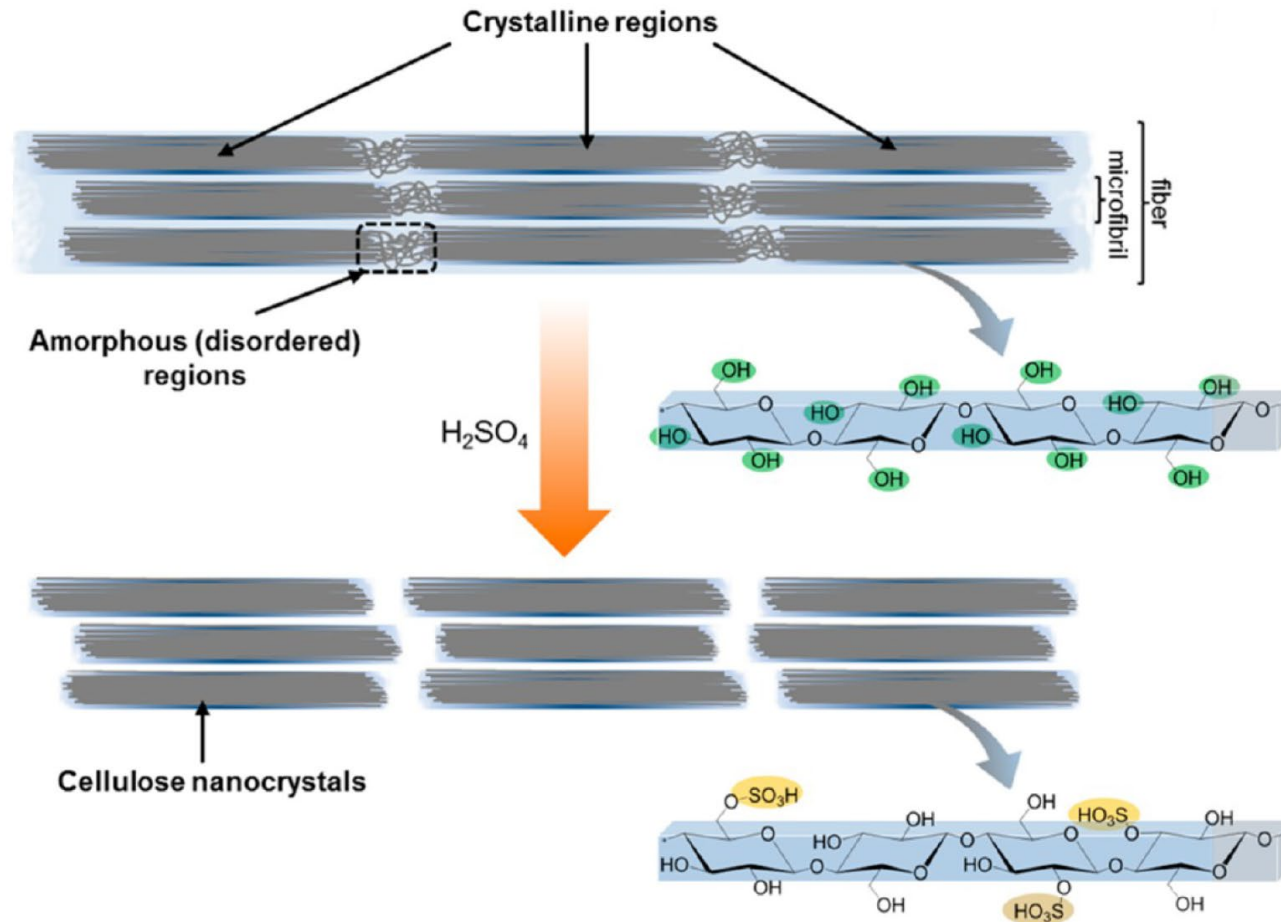
Cellulose Nanocrystal - Shape Memory Photonic Thermoplastic Composites for Information Encryption

Zongzhe Li

MacLachlan Group
Department of Chemistry
University of British Columbia
06/14/23



Cellulose Nanocrystals (CNCs)



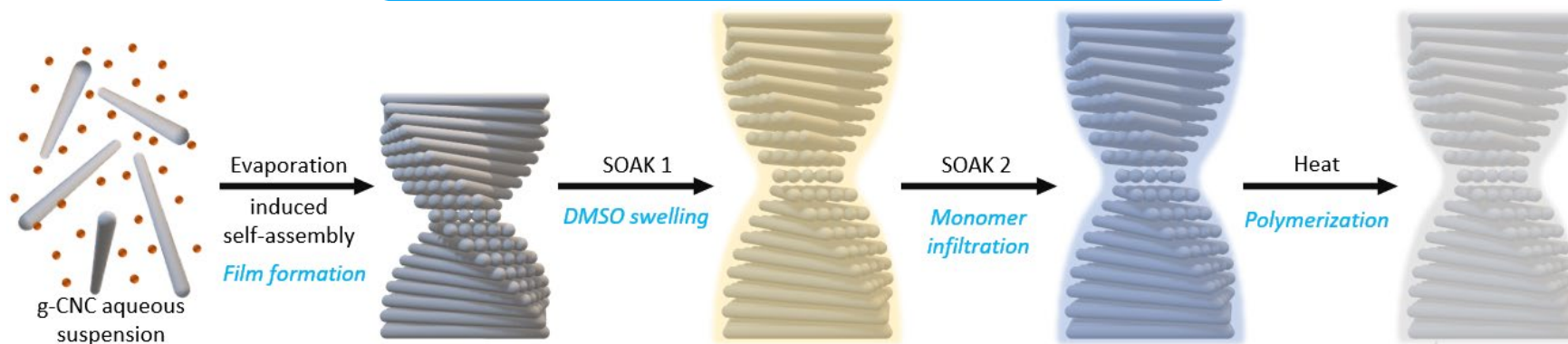
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Biomacromolecules 2014, 15 (7), 2327–2346.

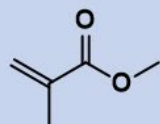
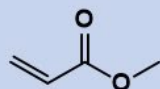


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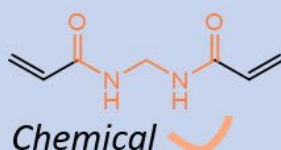
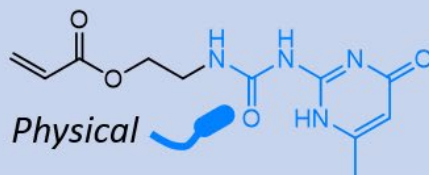
CNCs in Shape Memory Polymer



Co-monomers



Crosslinkers



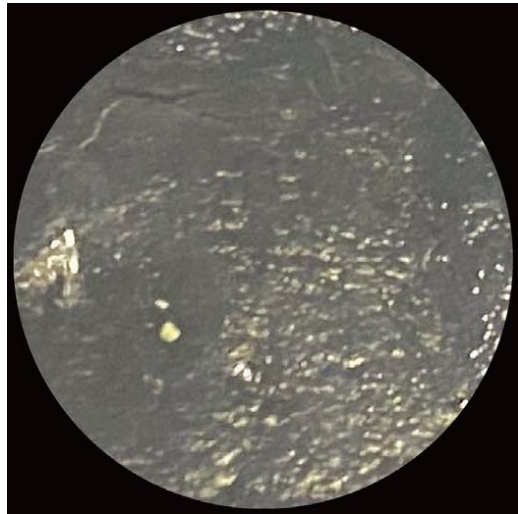
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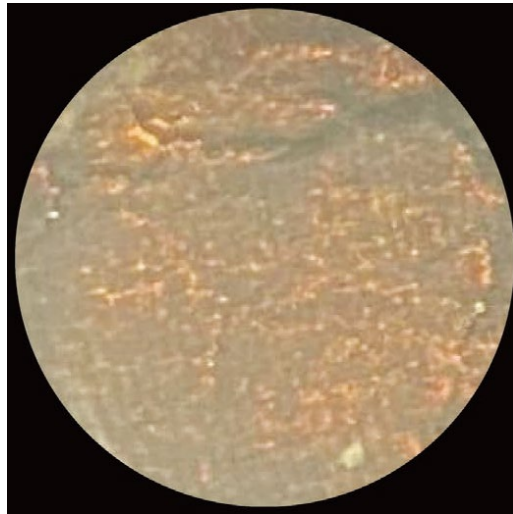
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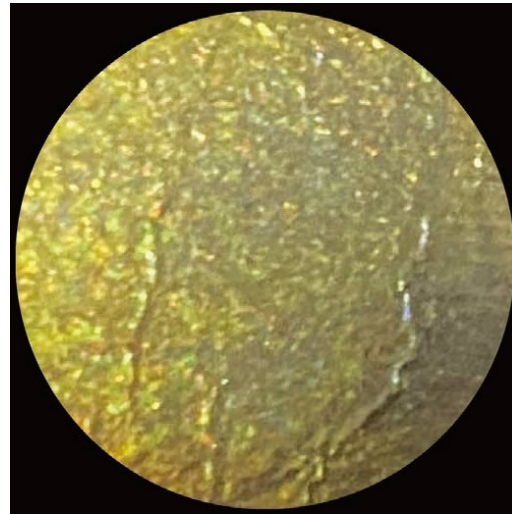
CNCs in Shape Memory Polymer



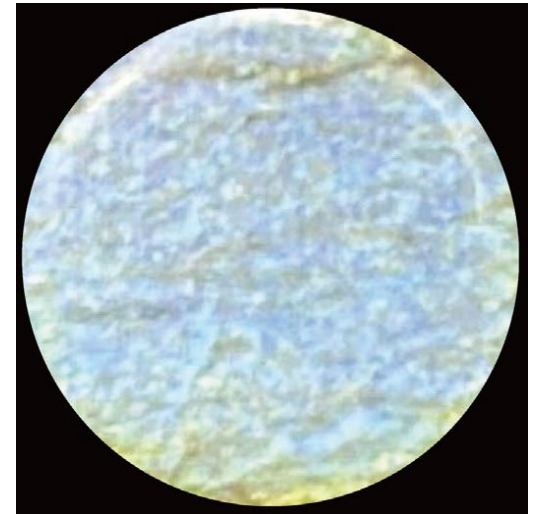
0 N



140 N



180 N



230 N



Pressing



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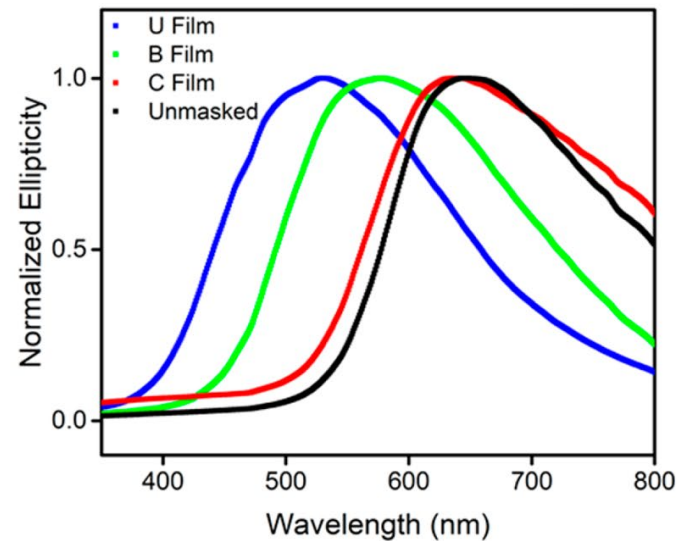
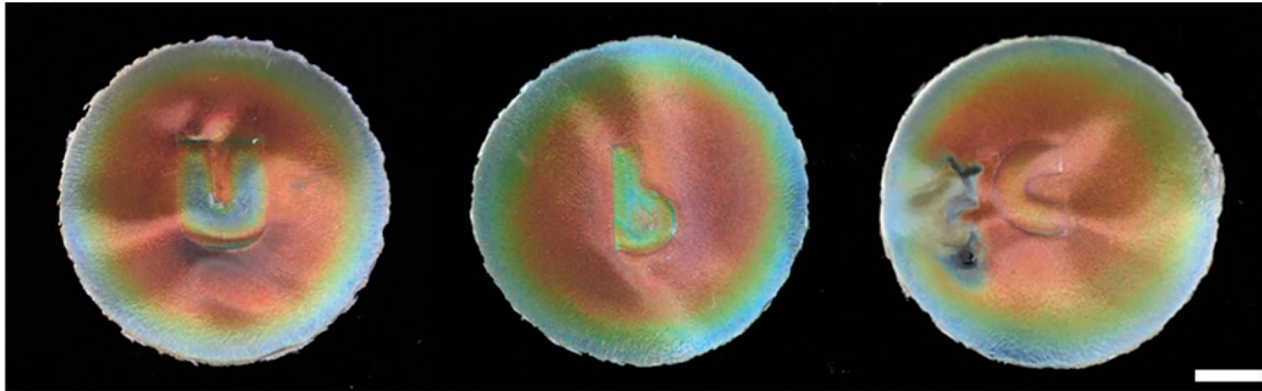
Adv. Funct. Mater. 2021, 31 (43), 2103268.



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Information Encryption: Approach 1 - Patterned Film



ACS Appl. Nano Mater. **2018**, *1* (7), 3098–3104.



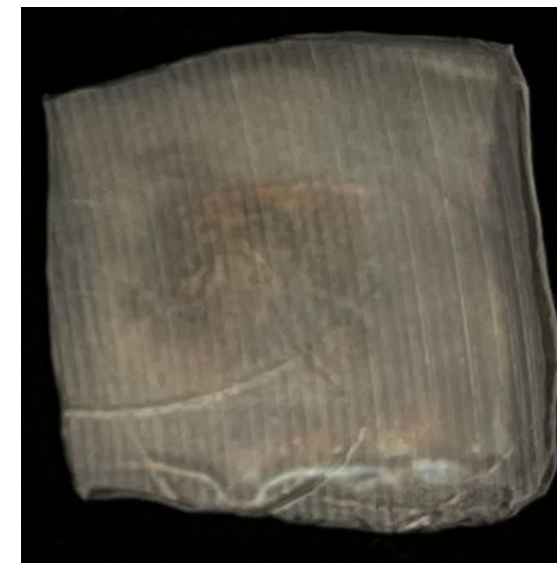
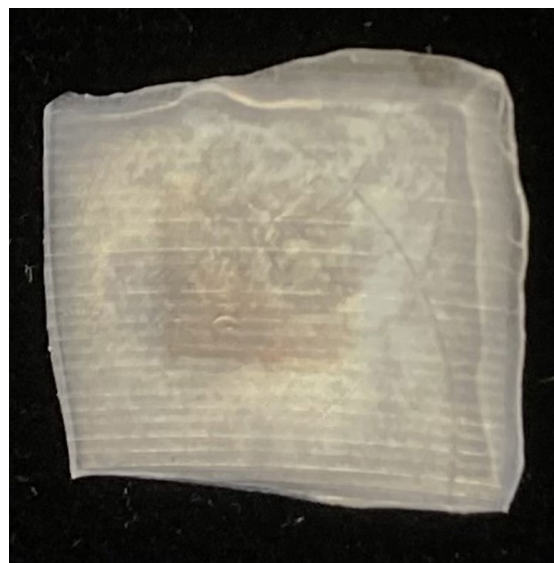
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Information Encryption: Approach 1 - Patterned Film



Pressing

Poor resolution...

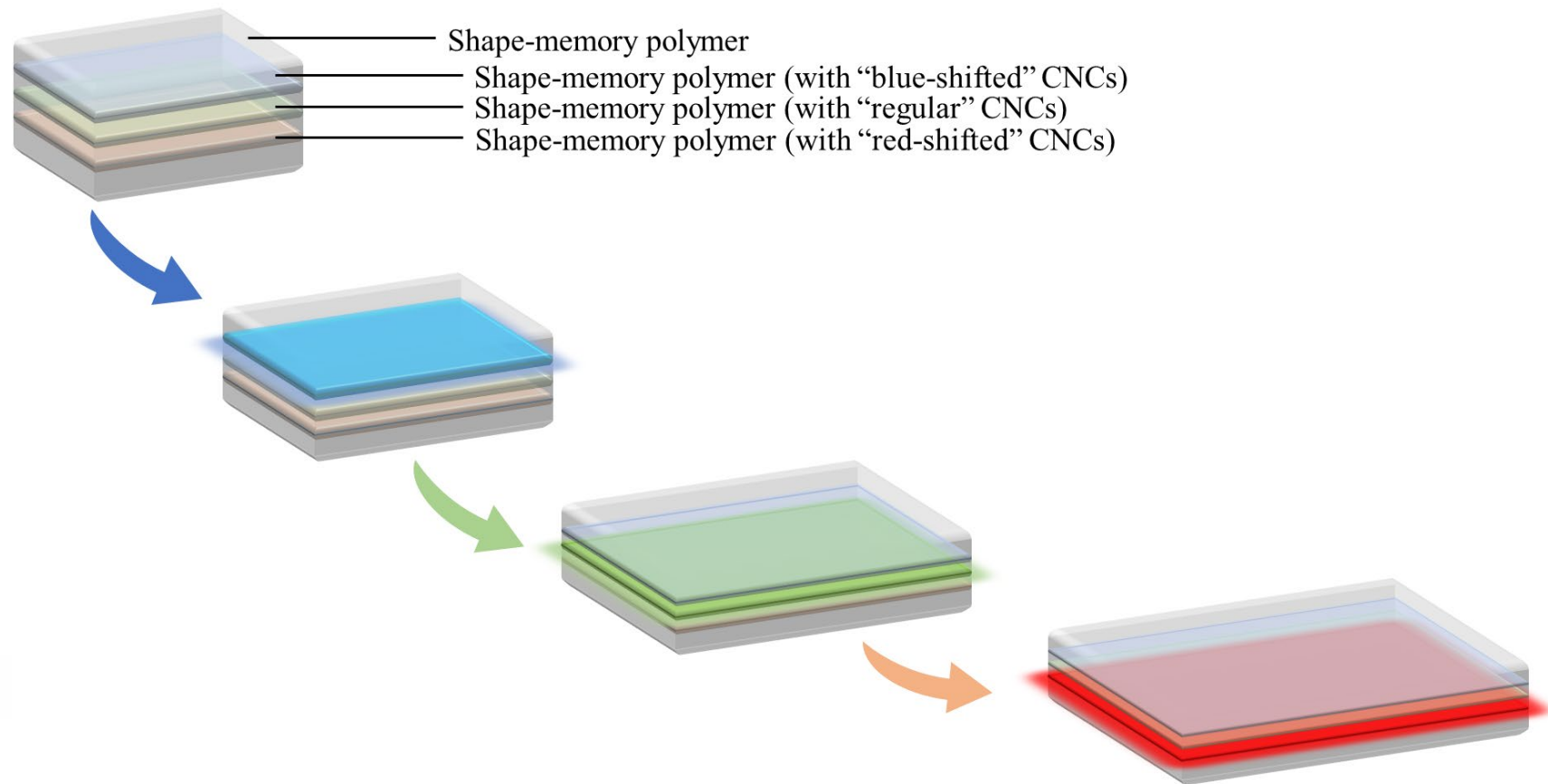


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Information Encryption: Approach 2 - Multilayers

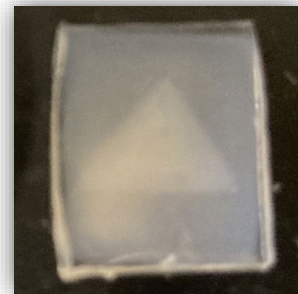
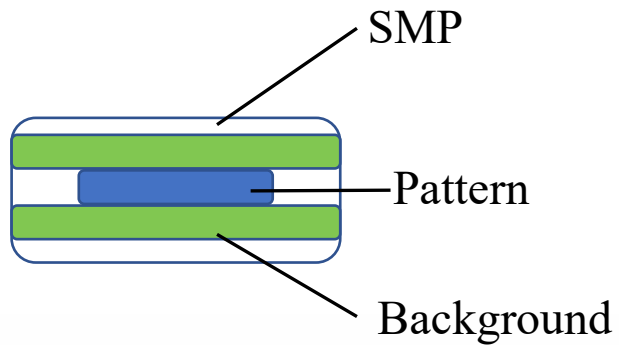
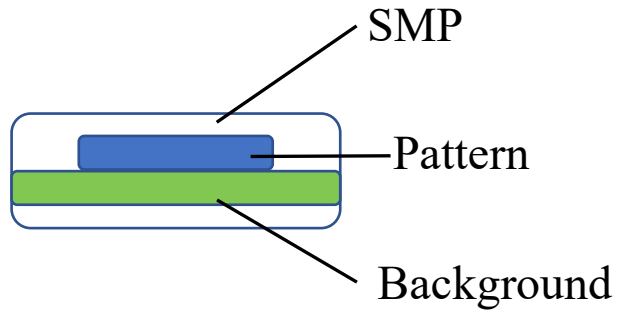


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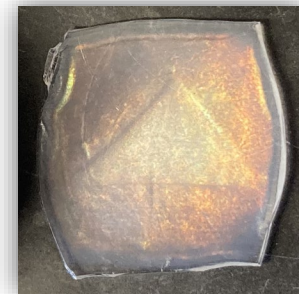


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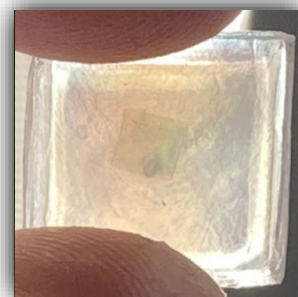
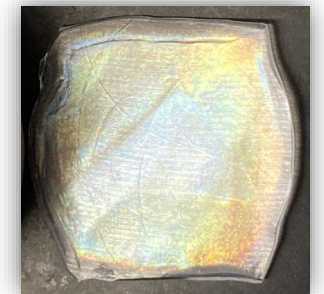
Information Encryption: Approach 2 - Multilayers



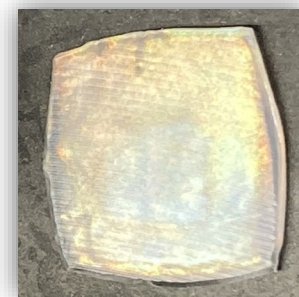
Press 1



Press 2



Press 1



Press 2

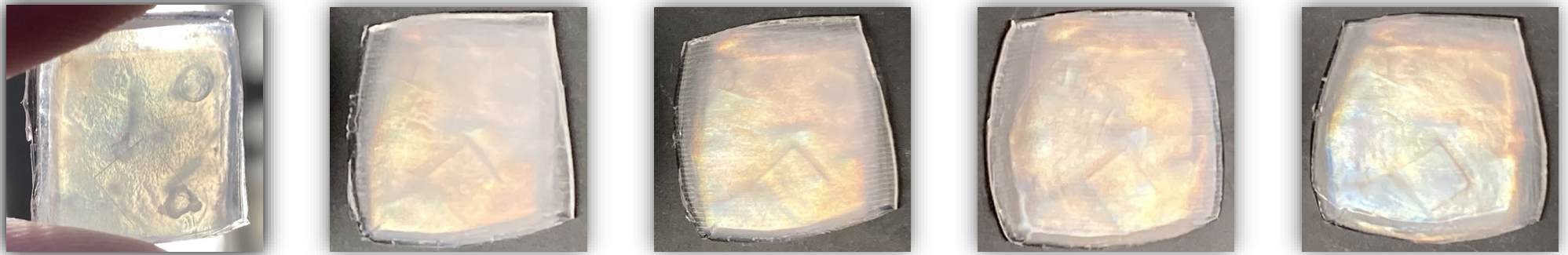
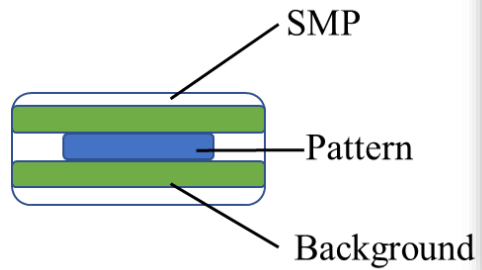


Information leakage

Pattern layer: Blue-shifted CNC film
Background layer: Red-shifted CNC film

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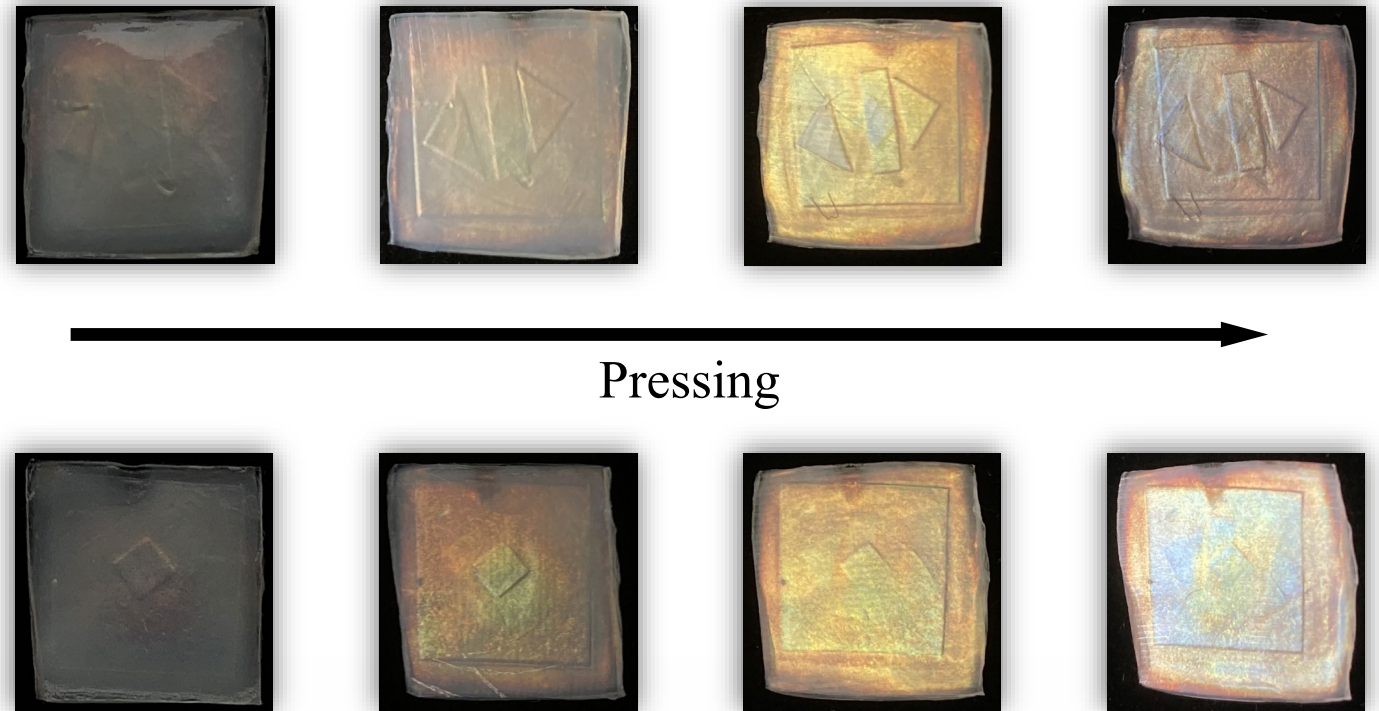
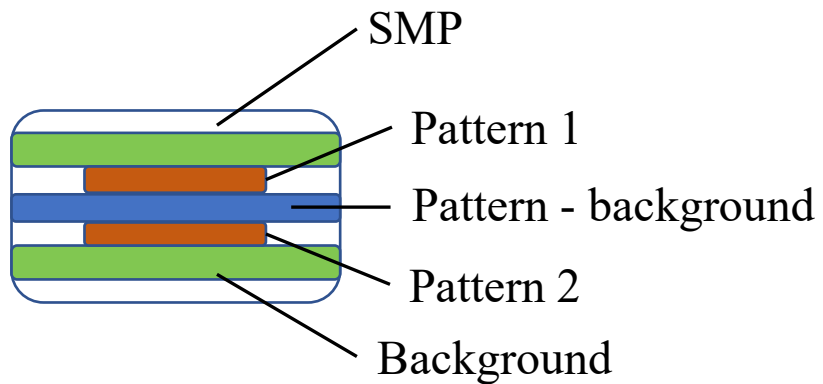
Information Encryption: Approach 3 - Cellulose Acetate (CA) Pattern



Pressing

Information Encryption: Approach 3 - Cellulose Acetate (CA) Pattern

“Patterned Pattern”

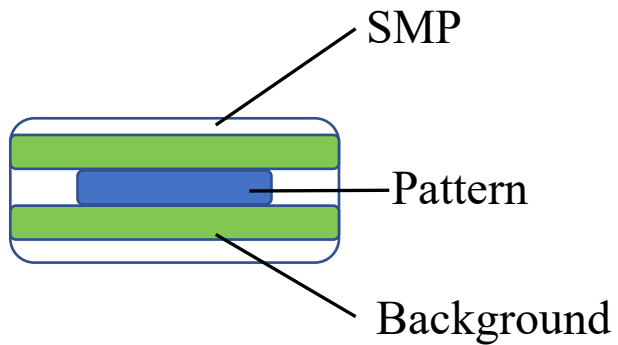


Pattern layer: Cellulose Acetate film
Background layer: Blue-shifted CNC film



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Information Encryption: Approach 4 – Graphene Oxide (GO) Background

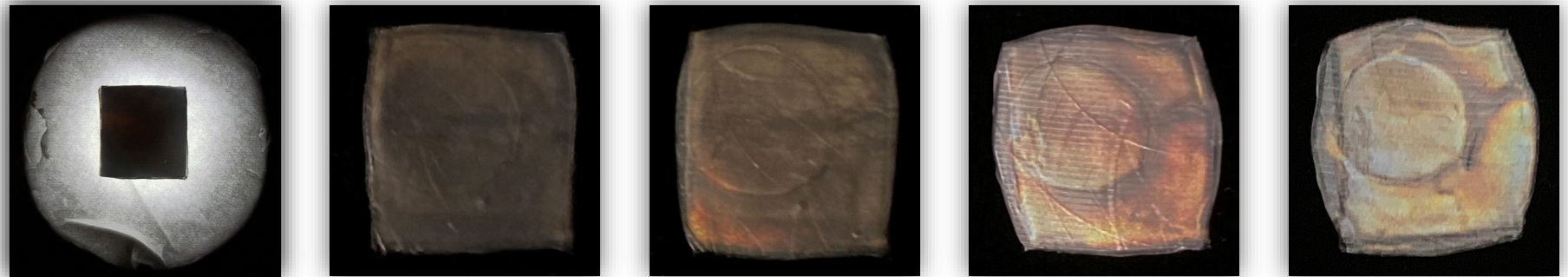
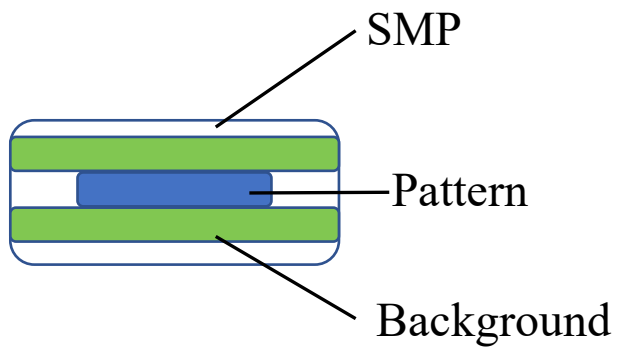


Pressing

Background cracks...

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Information Encryption: Approach 5 – GO-CNC Background

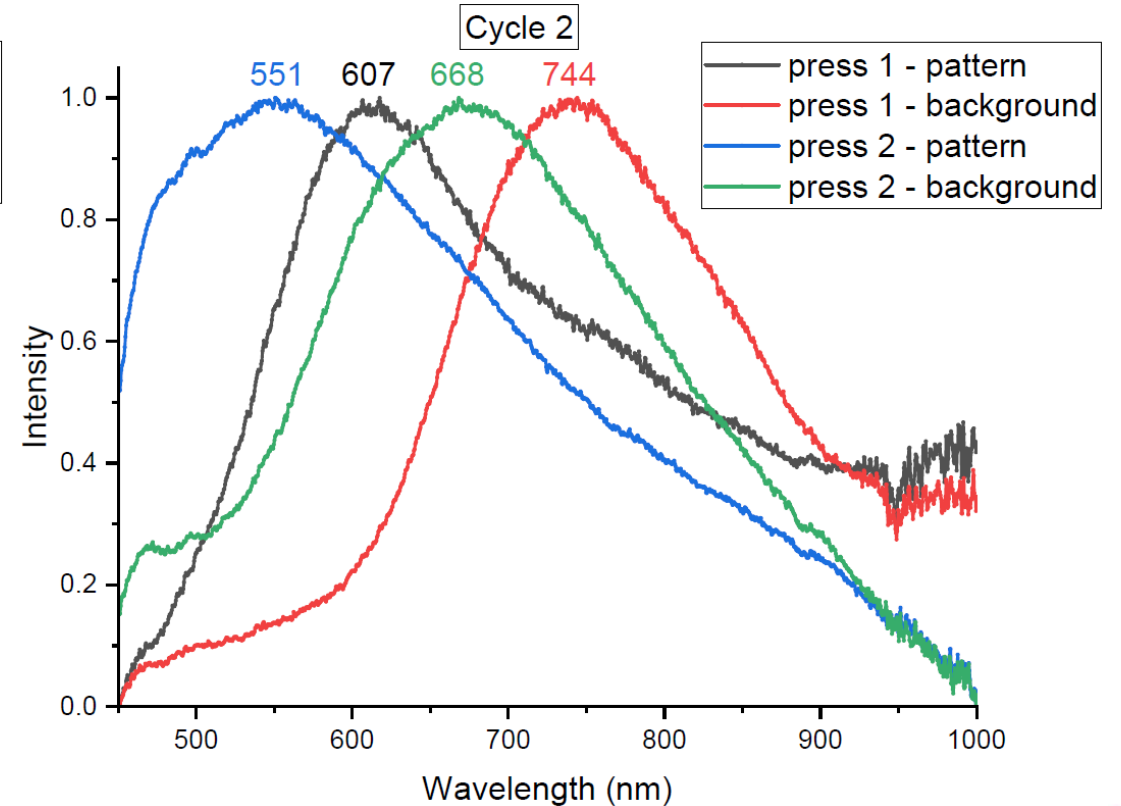
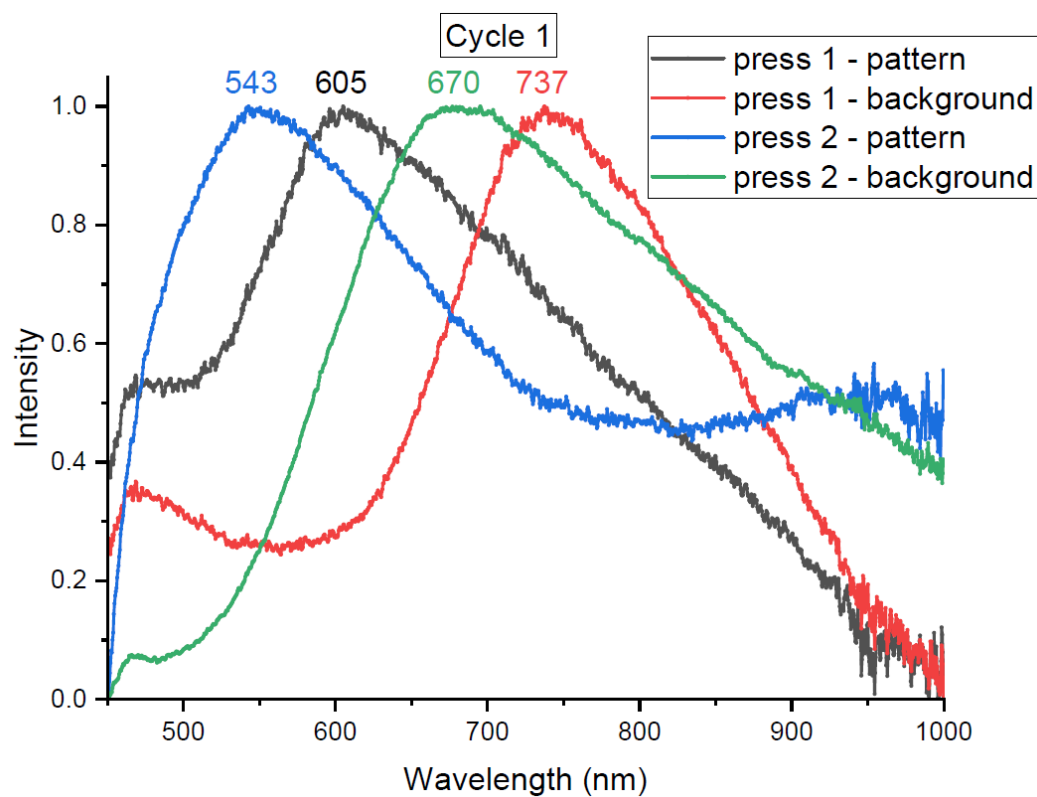


Pressing

All GOOD!

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CNC-SMP Cyclic Compression tests: Reflection Spectrum



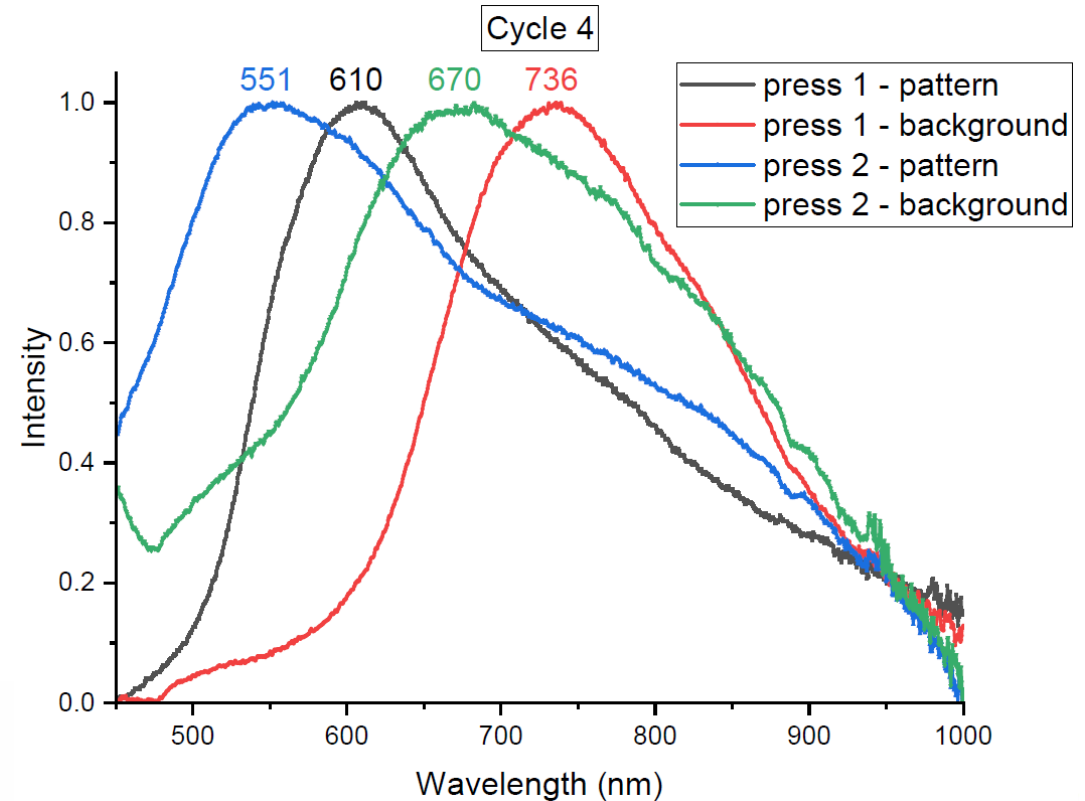
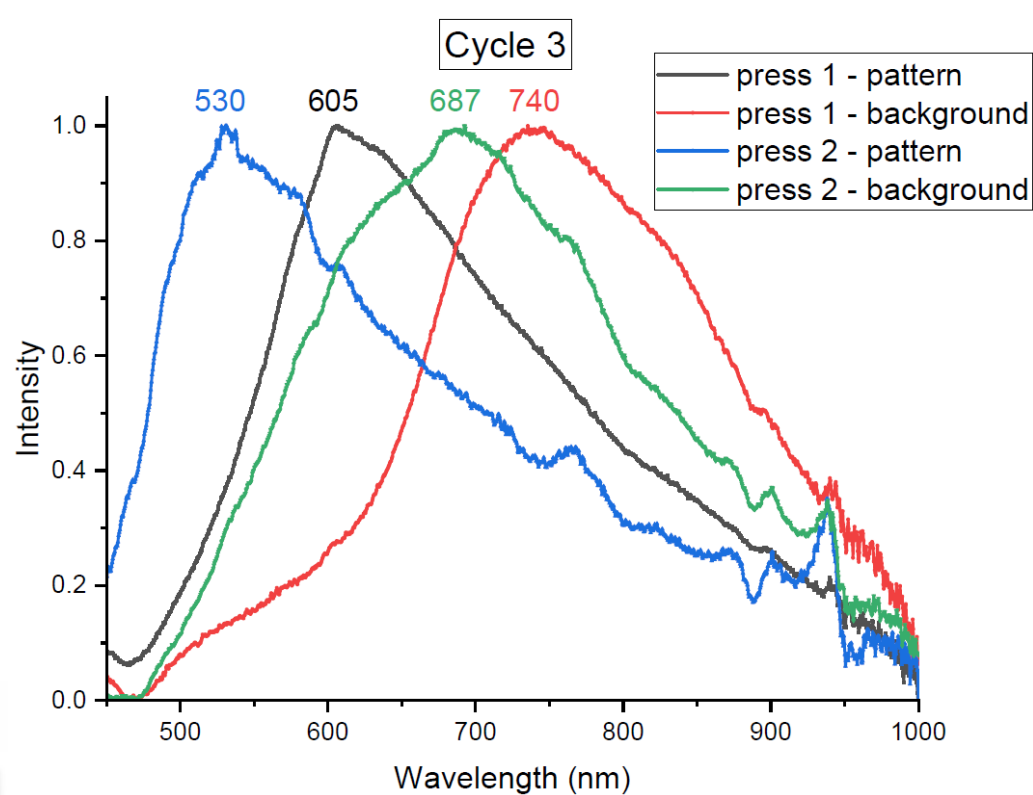
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CNC-SMP Cyclic Compression tests: Reflection Spectrum



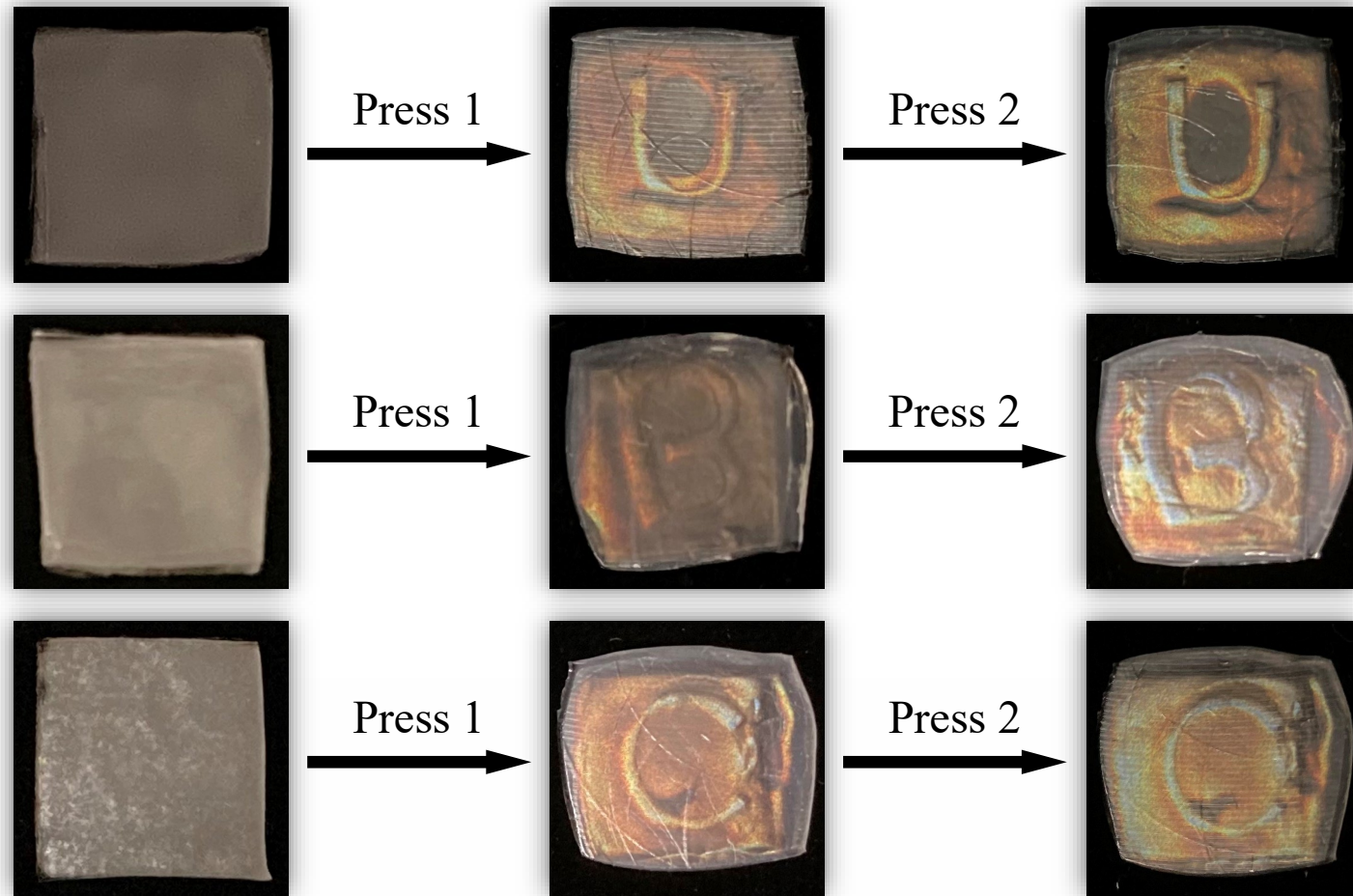
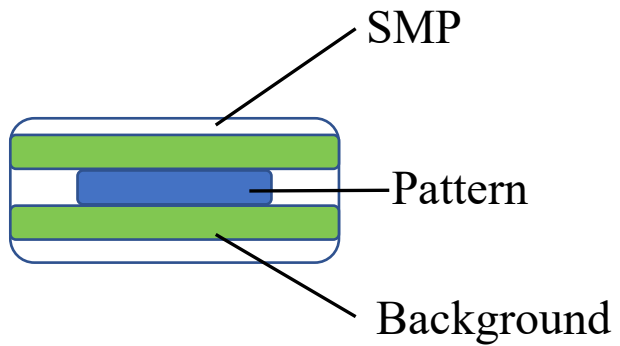
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Nice recovery



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CNC-SMP for Information Encryption



Pattern layer: Cellulose Acetate film
Top background layer: Blue-shifted CNC film
Bottom background layer: GO - CNC film

Conclusions

- 5 different approaches
- Chiral nematic aligned CNC embedded into shape-memory polymer matrix
- Photonic responsiveness to different pressure
- Cellulose acetate works as pattern (information carrier)
- Regional increase in pressure differentiate the pattern from background
- Graphene oxide prevent the information leakage
- Stable over 4 pressing-recovering cycles



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Acknowledgements



- Dr. Mark MacLachlan
- Dr. Miguel Soto
- Dr. Wadood Hamad



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