

Mass production and industrial applications of flexible structural materials

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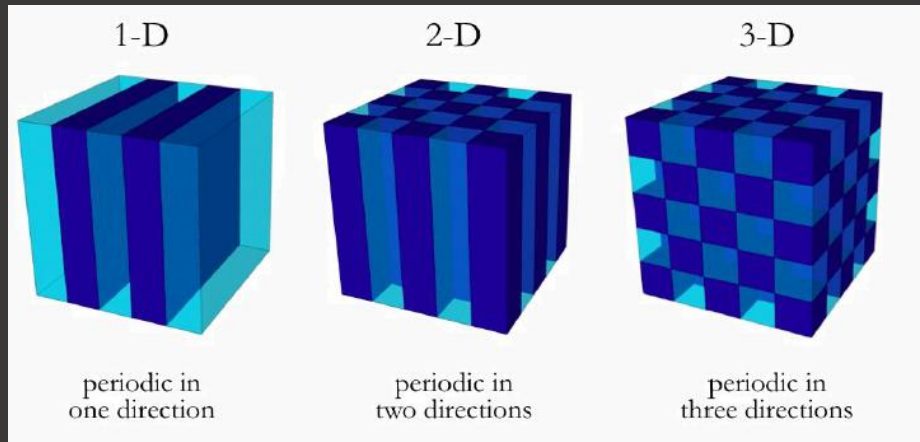
Structural Colors in Nature

Structural colors in nature originate from light interaction with photonic crystals

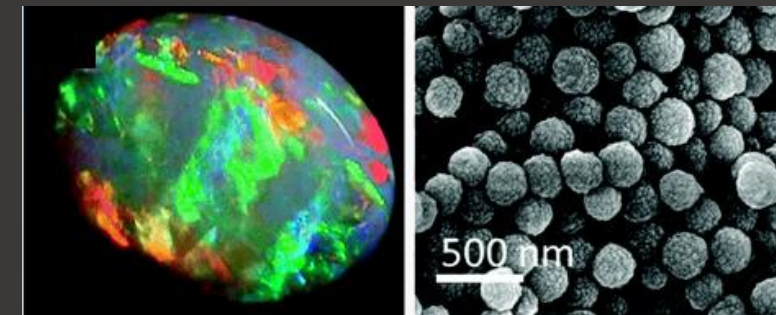
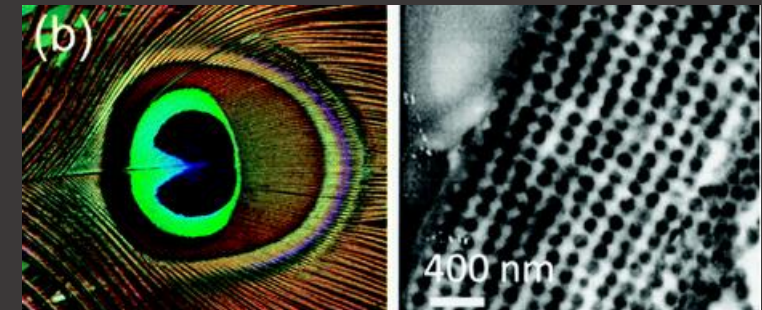
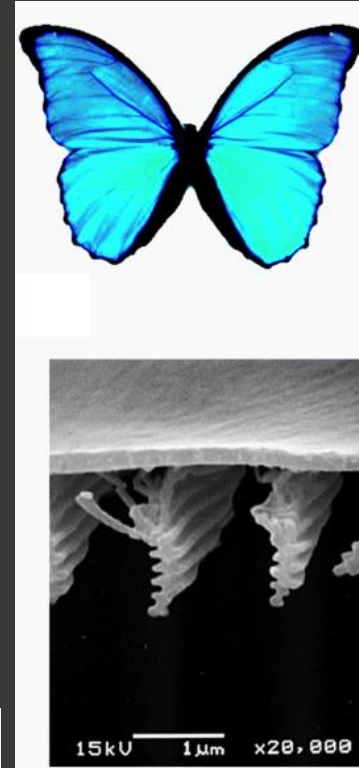
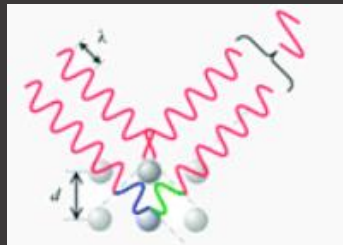


The Science behind Structural Colors

Photonic crystal: periodically structured electromagnetic media with lattice constants comparable to the wavelength of light



Photonic Crystals
Molding the Flow of Light

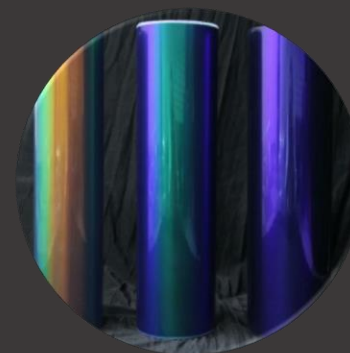
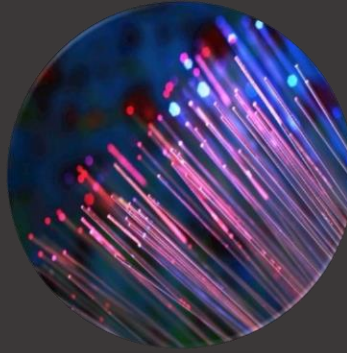


Review: E. Armstrong and C. O'Dwyer, J. Mater. Chem. 2015, 3, 6109-6143

Photonic Crystals Applications

Optical communications

- Photonic crystal fibers
- Photodetectors
- Optical switches

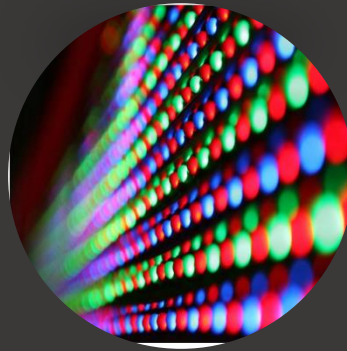


General Industrial

- Structural color
- Security materials
- Sensor

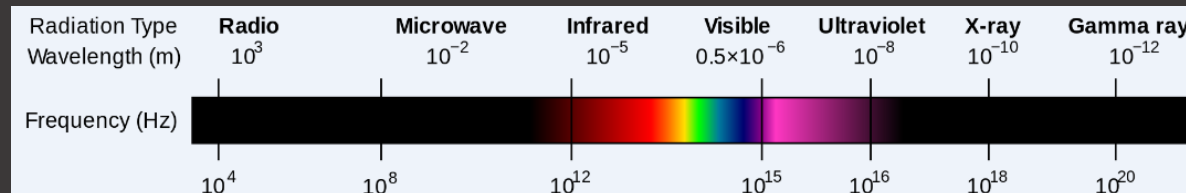
Consumer electronics

- Semiconductor lasers
- LCD and LED displays
- LED lighting



Renewable energy

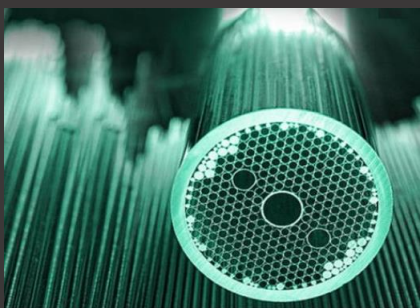
- Solar energy harvesting
- Thin film photovoltaics



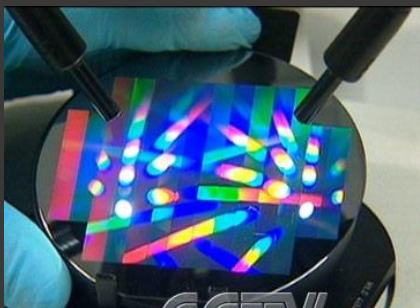
Electromagnetic Control is Feasible with Photonic Crystals

From Rigid to Flexible Photonic Crystals

Rigid



Photonic Crystal Fiber

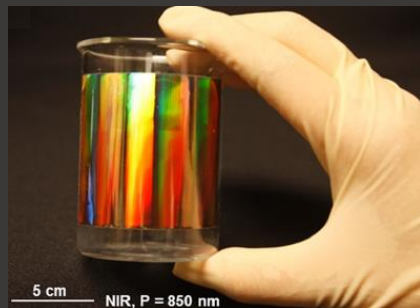


LED with PC Structure

Flexible

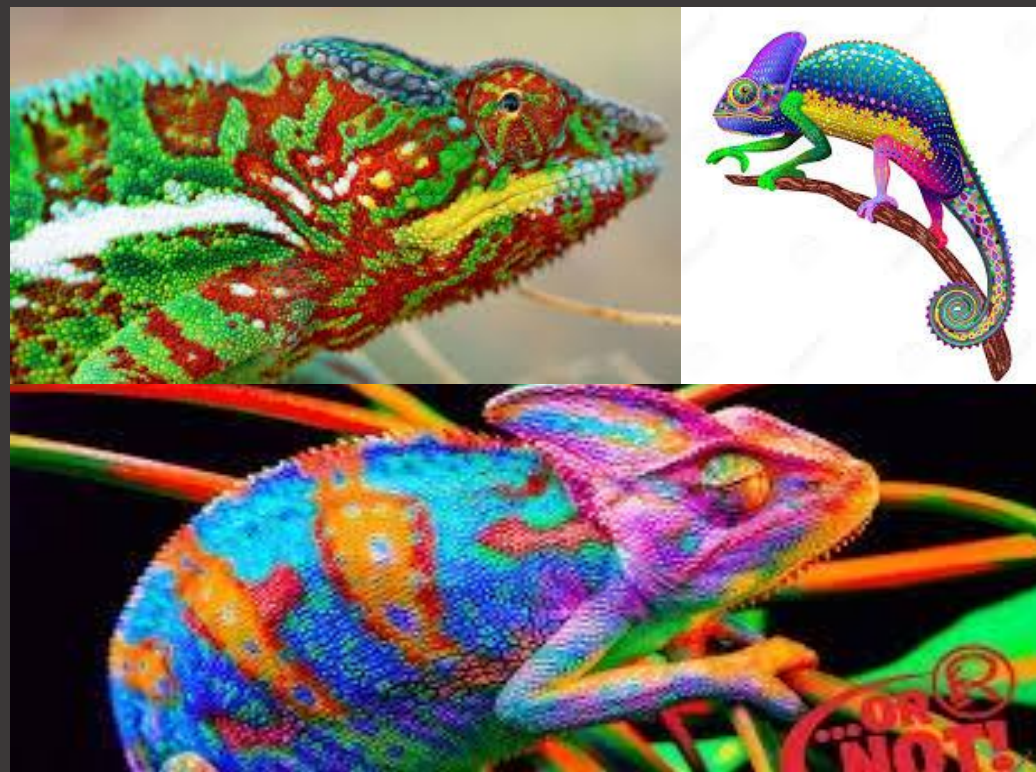


Color Sensing

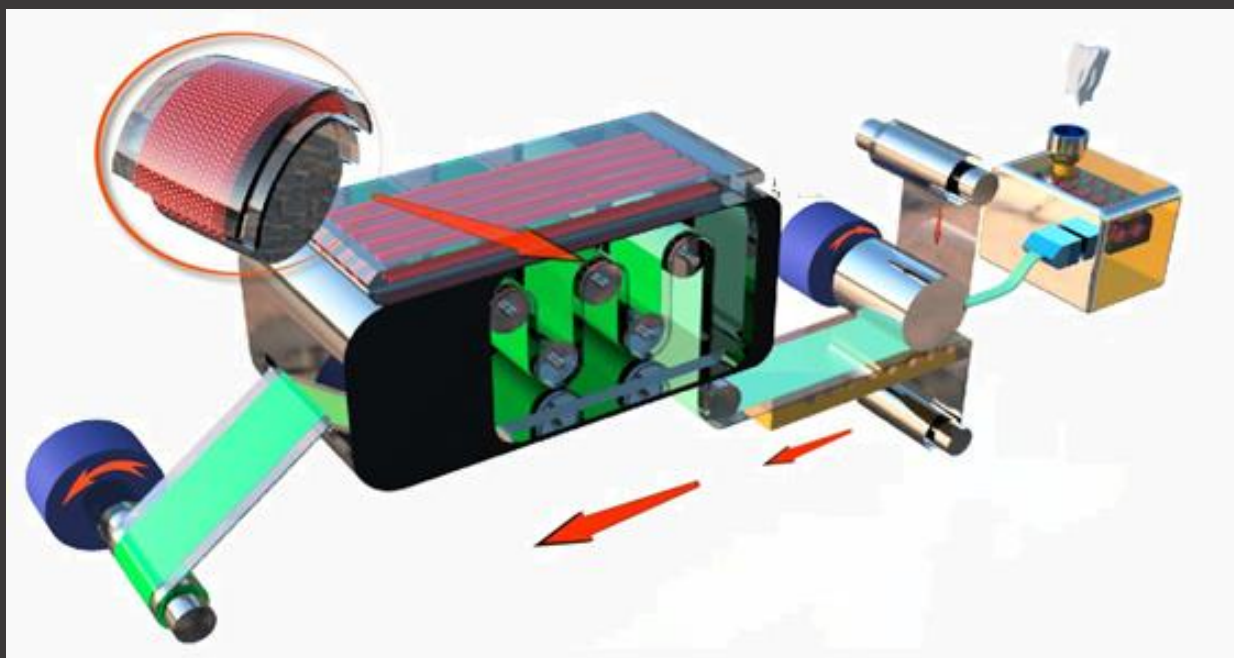
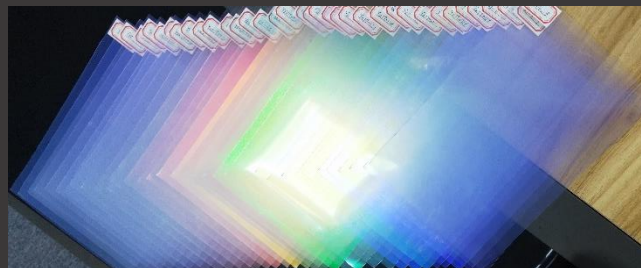


Negative Index Metamaterial

Photonic crystals cause active color change in chameleons



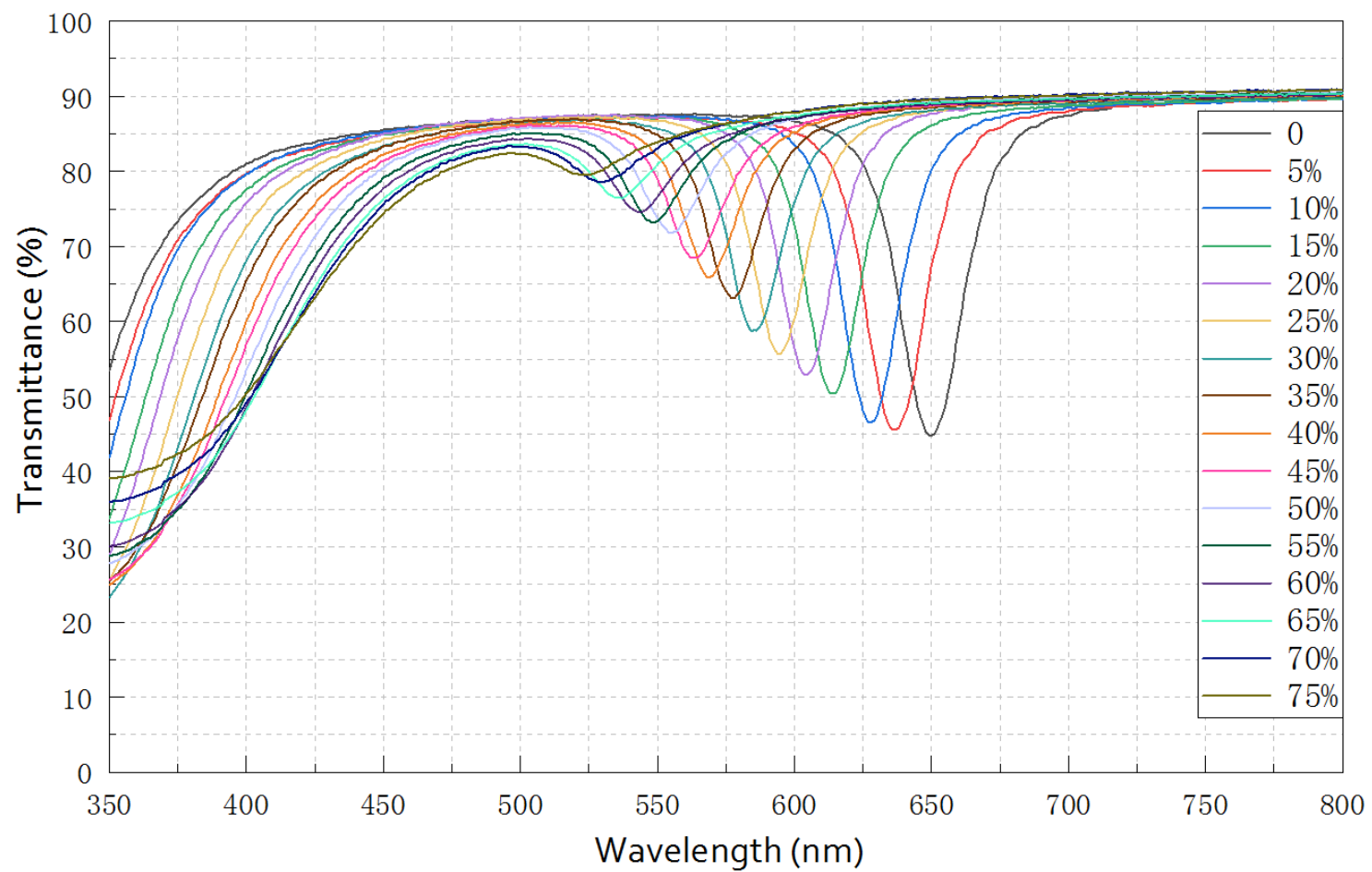
Industrial Scale Manufacturing



Tunable Color Change

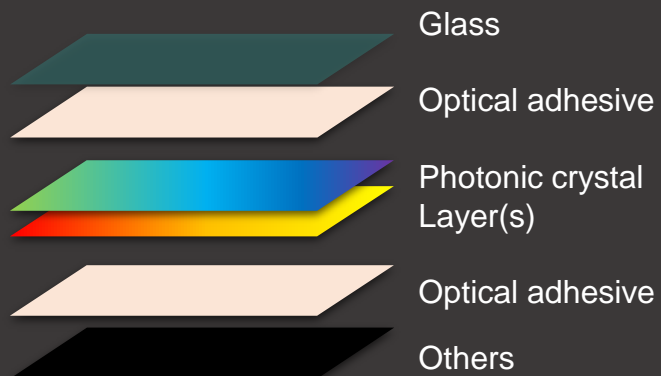


Mechanochromic TPU Polymer Opal



Commercialization Case: Color-shifting Gradient Aurora Effect

Gradient Color across Visible Light Spectrum
(roll-to-roll film lamination)



Process:

Continuous vs. batch

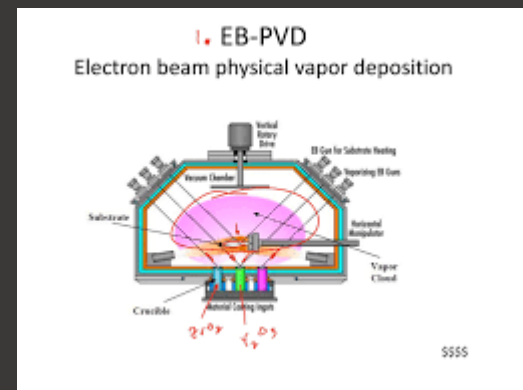
Performance:

Aesthetic diversity

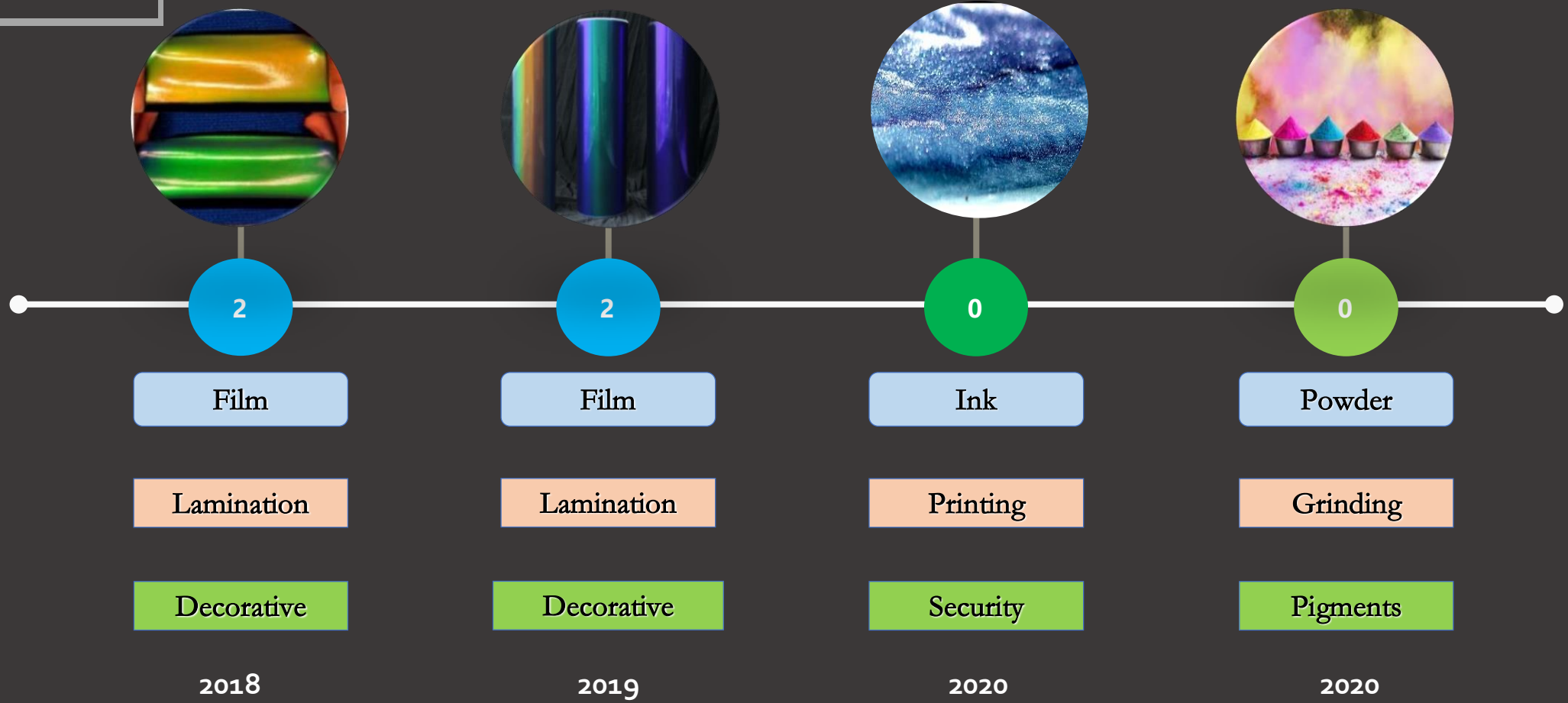
Cost:

low vs high

Physical Vapor Deposition (PVD)
(current technique for Aurora coating)



Product Formats



Technology Platform

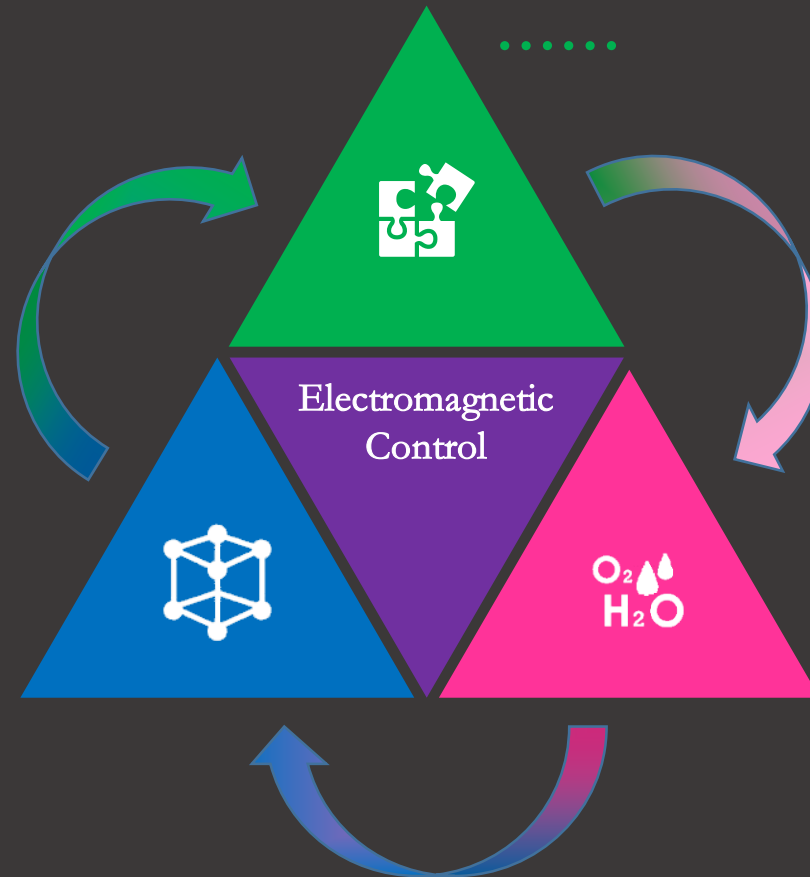
Components

High order symmetry (e.g. strawberry)

Asymmetry (e.g. Janus)

Mesoporous

.....



Microstructure
Photonic crystal
Double gyroid
.....

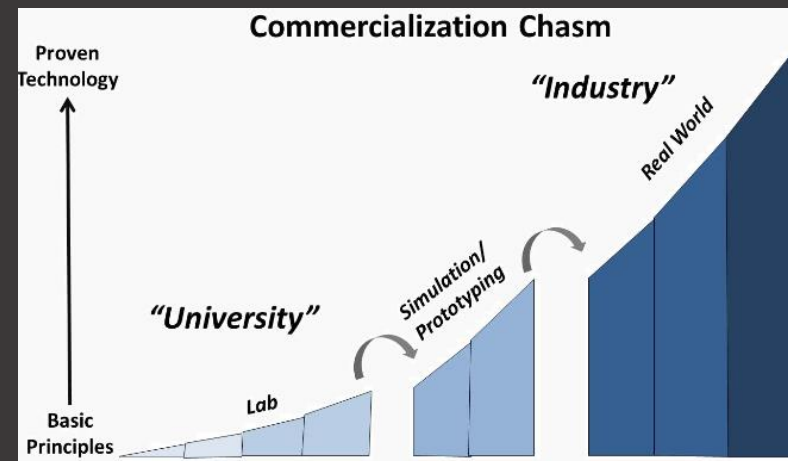
Chemical
Organic
Semiconductor
Metal
.....

Path for New Material Commercialization

Materials/chemicals (new product launch)



- Understand the value proposition
- Clear picture of the value chain, entry barriers and key influencers
- Commercialization strategy / direction



From proof-of-concept prototype by nanofabrication to industrial production & commercialization

Acknowledgement

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Thank you for your attention!



Science Makes Colorful Life