Bio-Inspired Photonics

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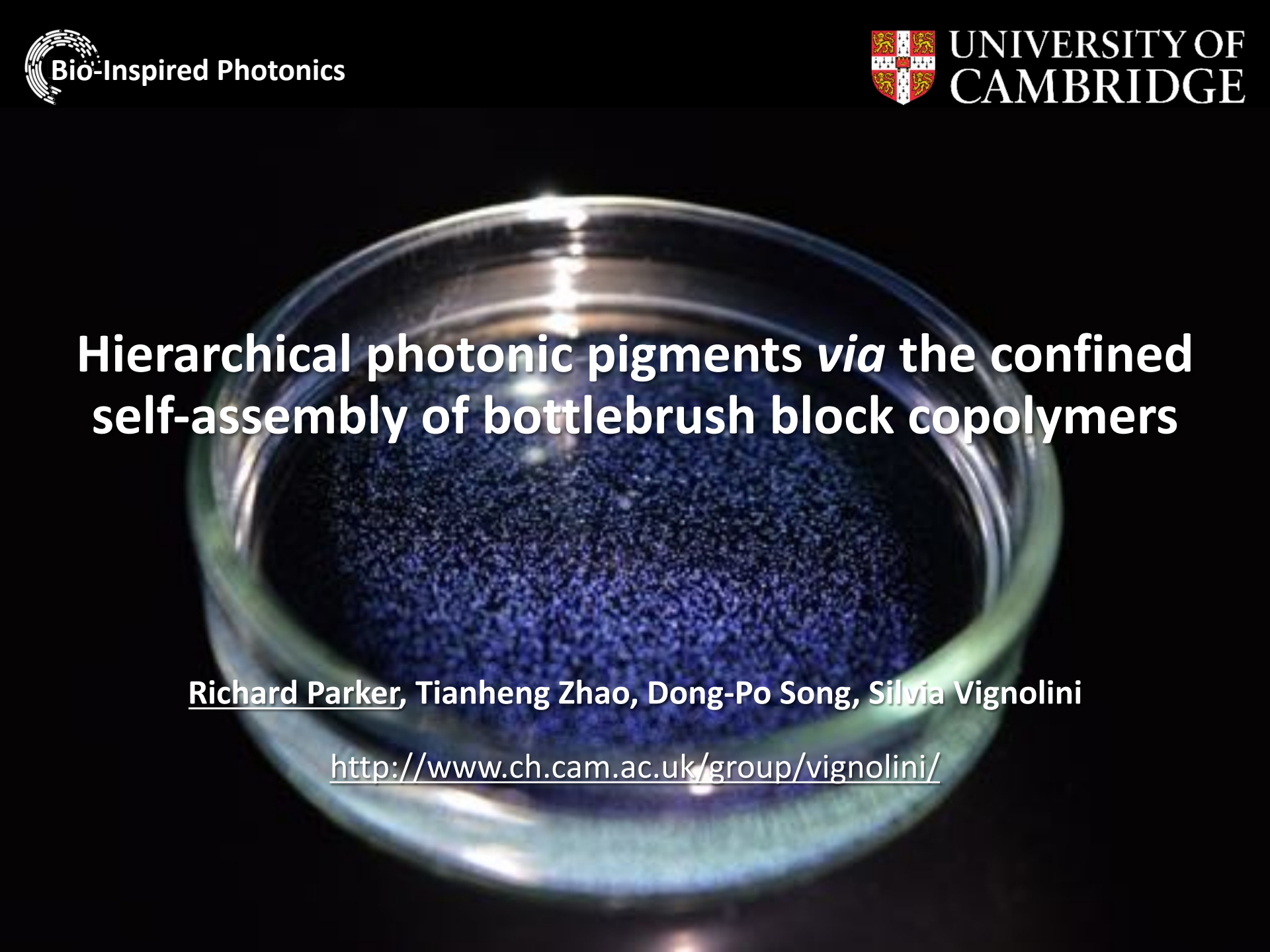


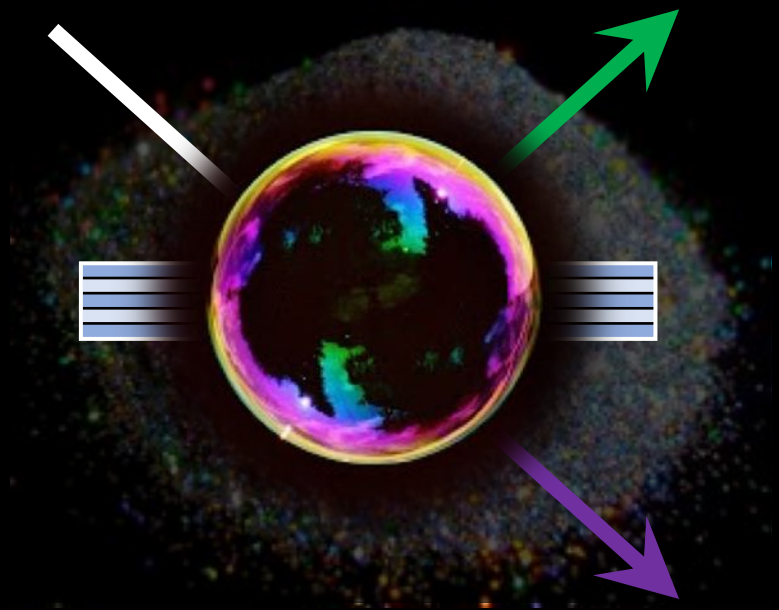
Hierarchical photonic pigments *via* the confined self-assembly of bottlebrush block copolymers

Richard Parker, Tianheng Zhao, Dong-Po Song, Silvia Vignolini

http://www.ch.cam.ac.uk/group/vignolini/

Colour and structure

Part of the light is absorbed, part is scattered (non-directional)



Part of the light is reflected (directional) part is transmitted. Reflected colour is STRONG but the material is TRANSPARENT

Photonic structures in nature

The most brilliant colours in nature are obtained from wavelength-sized transparent structures.

S. Kinoshita, Structural Colors in the Realm of Nature (2008)
O. Karthaus, Biomimetics in Photonics (2012)

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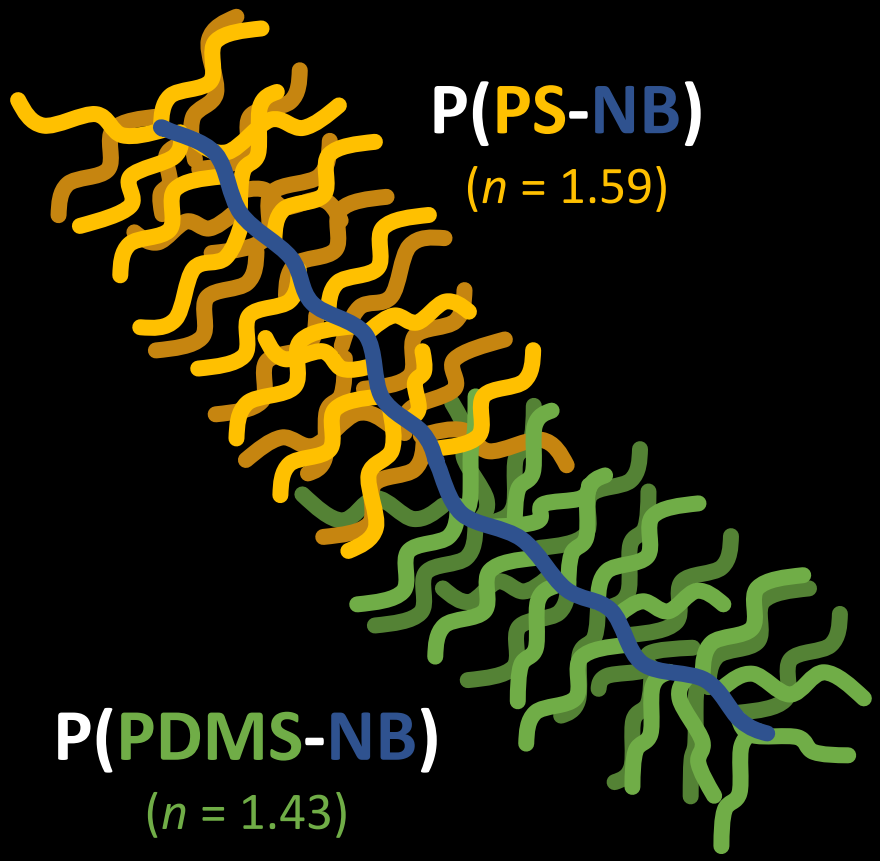
Bottlebrush block copolymers (BBCPs)



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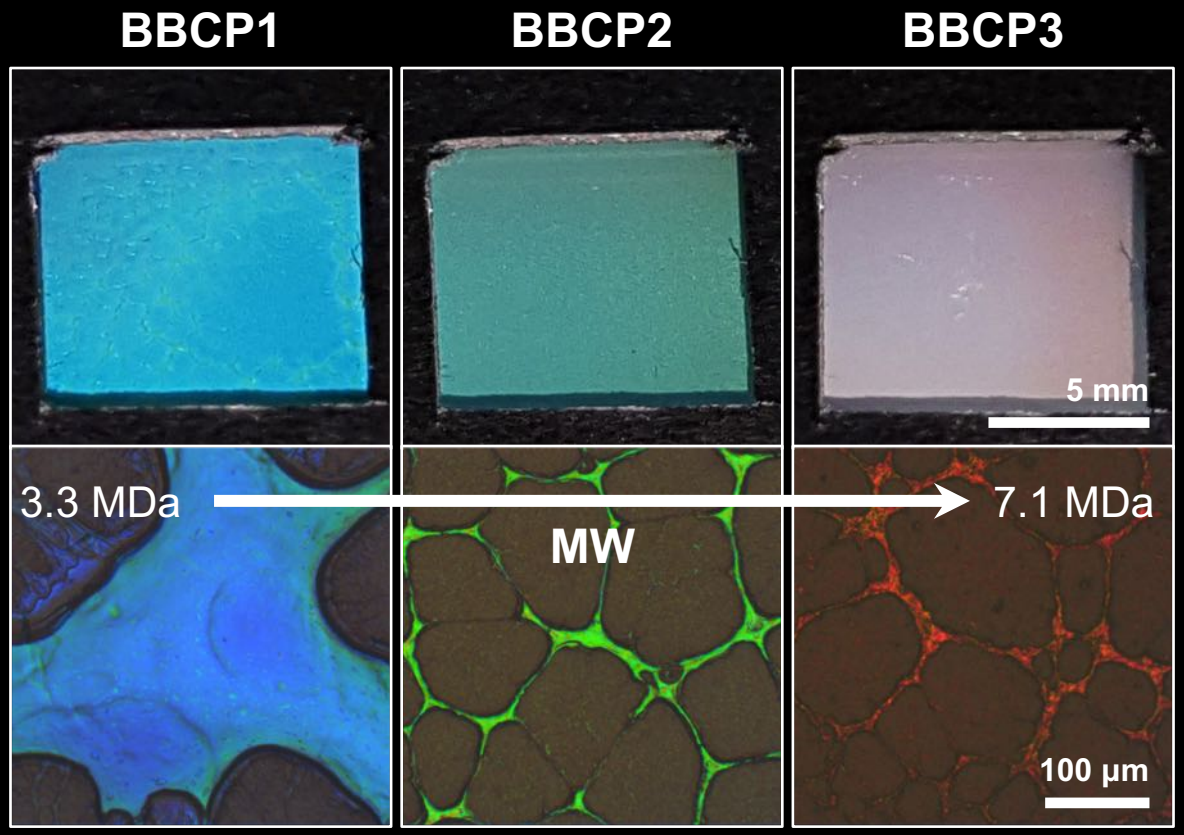
Photonic films from BBCPs



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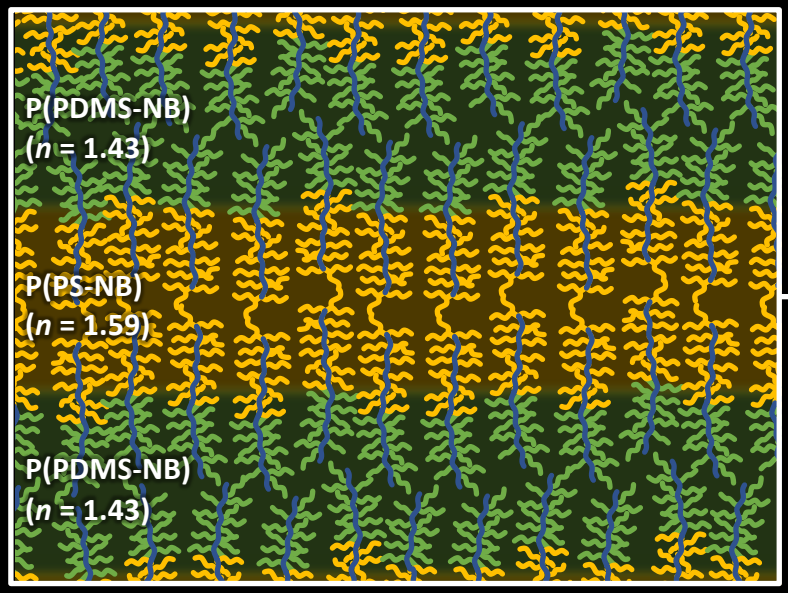
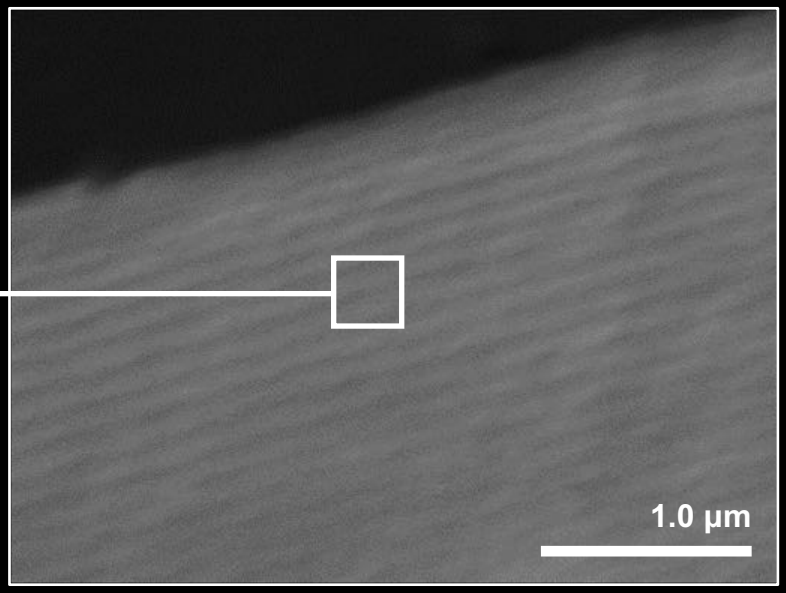
Photonic films from BBCPs





$$\lambda = 2\, nav\, d$$

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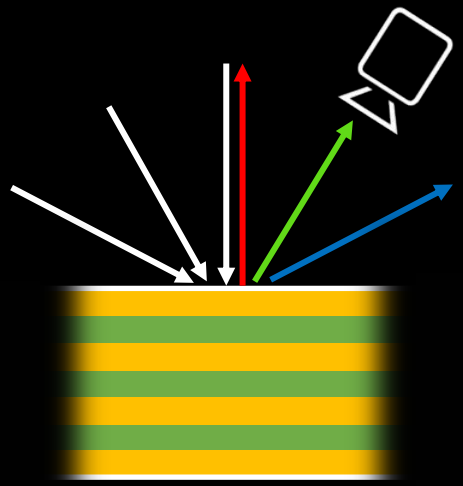
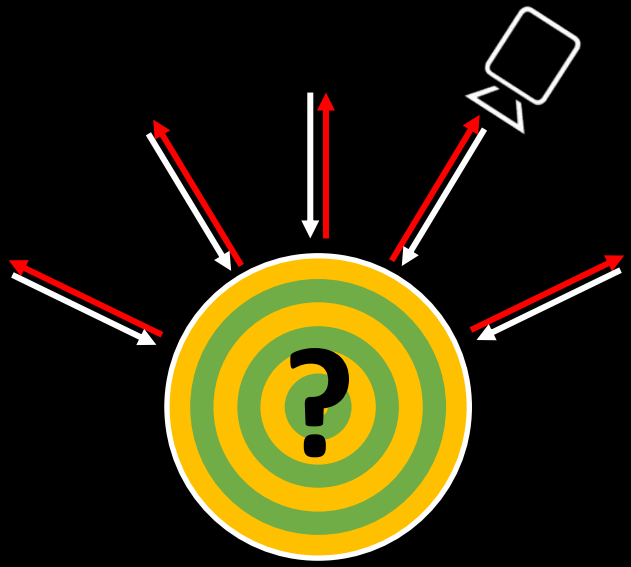
Hierarchical photonic pigments



iridescent



non-iridescent

self-assembly + confinement → new functionality

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Spherical confinement: microdroplets

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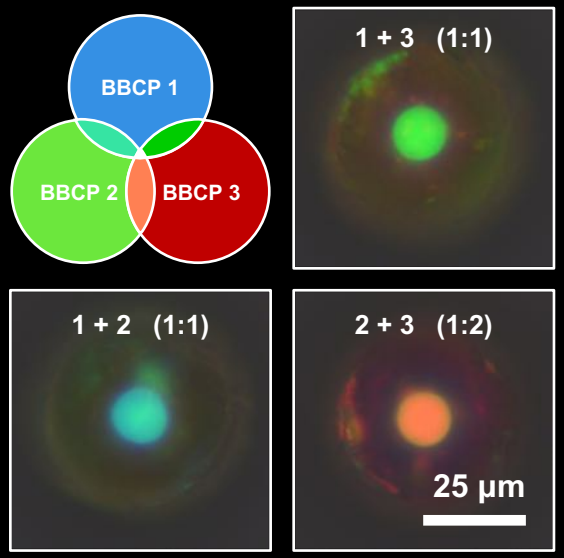
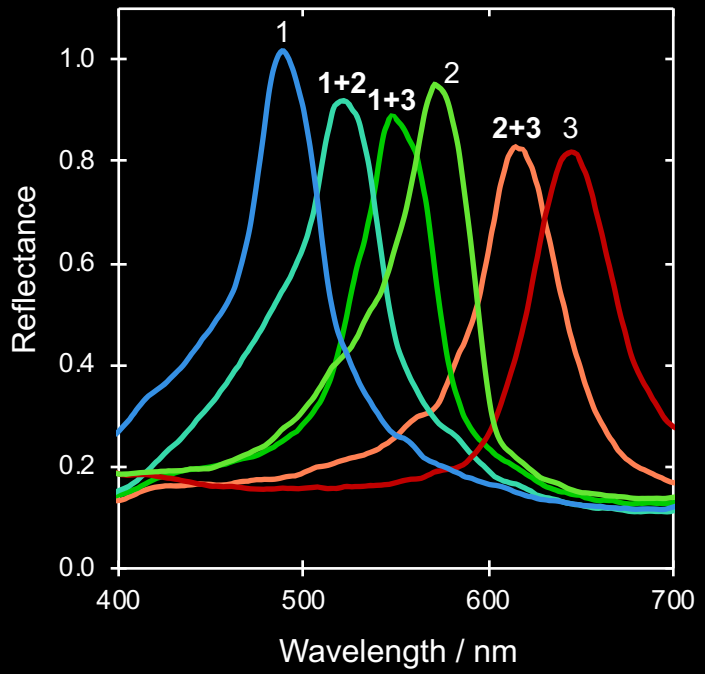
Expanding the colour palette





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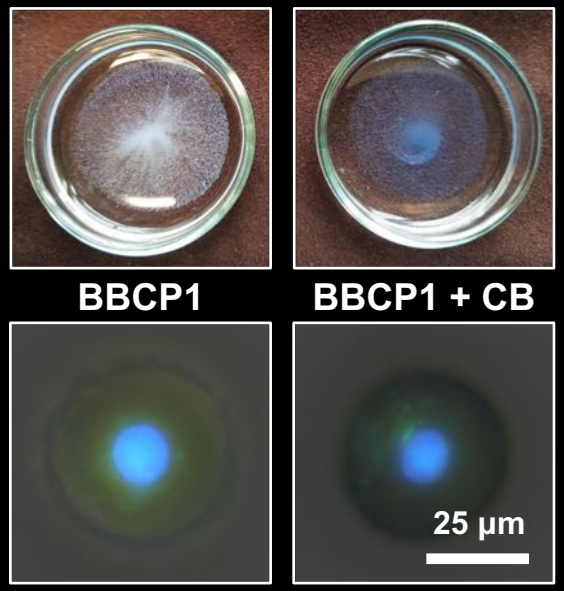
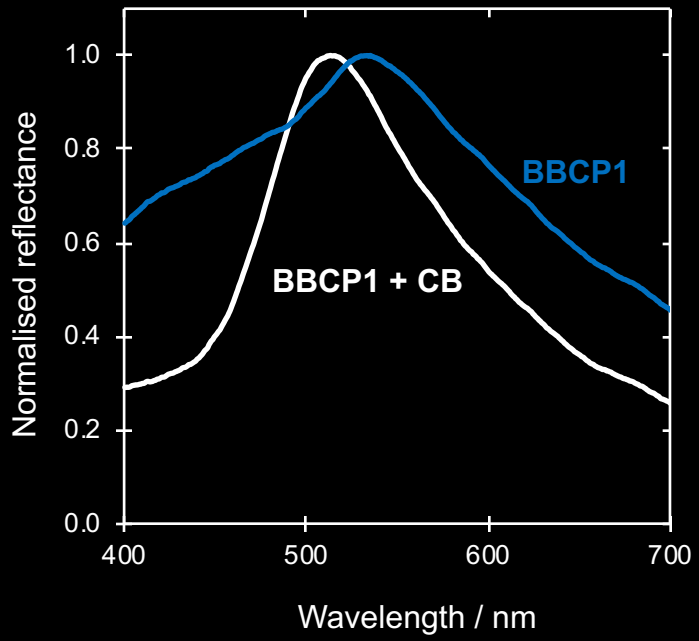
Functional additive - enhance the contrast





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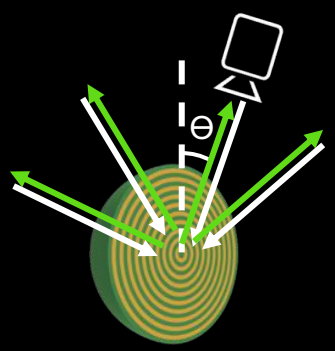
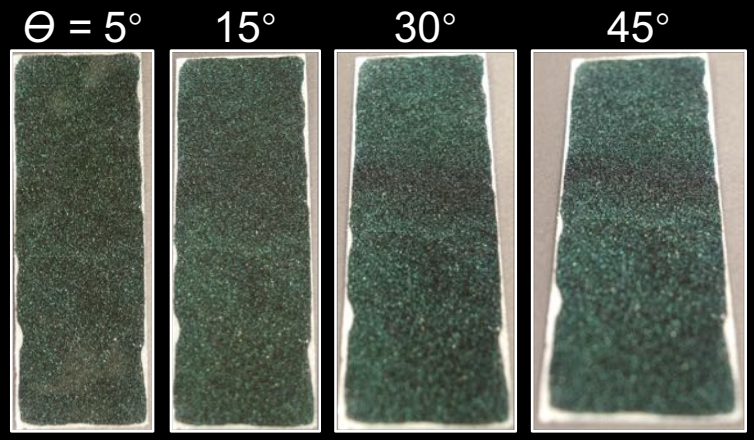
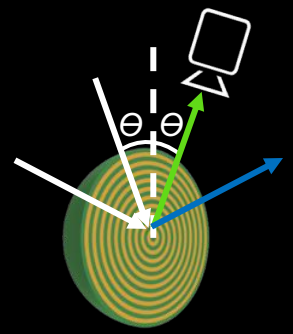
Structurally-coloured coatings

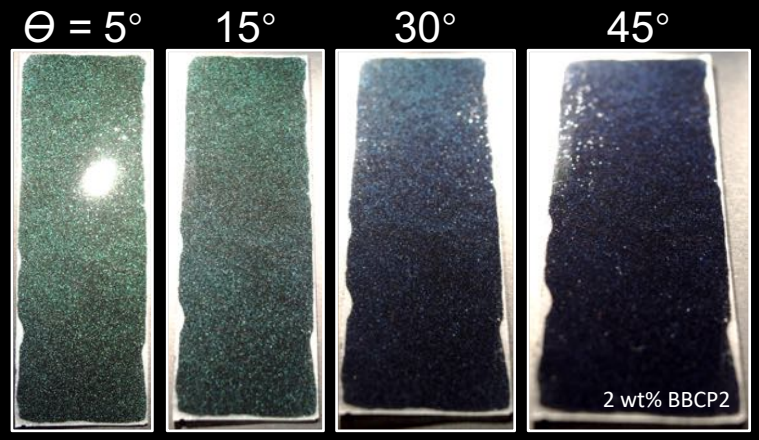


diffuse illumination





direct illumination



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Summary

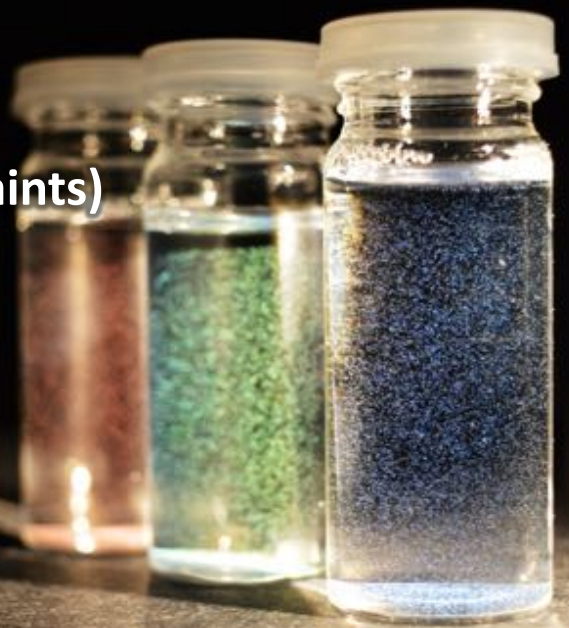
Hierarchical photonic pigments from BBCP microemulsions:

- intense reflected colour – up to 100%
- tuneable colour *via* the formulation
- stimuli-responsive colour upon selective swelling

Robust interface-templated assembly process:

- high tolerance to droplet size and drying rate
- long-range order with minimal defects
- functionality can be enhanced with additives

BBCP pigments can be embedded into coatings (e.g. paints)



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D.-P. Song, T.H. Zhao, G. Guidetti, S. Vignolini, R.M. Parker, *ACS Nano*, 2019, **13**, 1764.