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Structurally-coloured polymer pigments

Vibrant particles for fade-resistant colour

Structural colouration is responsible for many of the most brilliant colours found in nature; from iridescent beetles and metallic butterflies to the dazzling tail-feathers of the peacock. Inspired by such natural examples, Dr Silvia Vignolini and her team in the Department of Chemistry, University of Cambridge, have developed a scalable route to structurally-coloured synthetic polymer microparticles. Such pigments could replace existing "interference & effects" pigments, leading to a new generation of colourant products with applications ranging from automotive or architectural paints to anti-counterfeiting or responsive colourants. The team is now keen to collaborate with partners to validate this exciting new material.

Key Benefits

- Robust & scalable emulsion-based fabrication.
- Extremely high colour saturation.
- Very wide range of accessible colours, with good colour purity.
- Stable in a broad range of formulations.
- Diverse range of potential applications in paints, inks and coatings, with a choice of iridescent, pearlescent or matte appearance.

Dr Silvia Vignolini is a Reader in the Department of Chemistry. She has expertise in materials science and optics, and her research focuses on natural photonic structures for novel colourants.

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What problem does this material solve? Traditional organic dyes fade over time due to exposure to light, while more fade-resistant mineral dyes are often highly toxic. Commercial ‘interference pigments’, as found in iridescent paints, consist of thin flakes and are commonly made of unsustainable metal oxide-coated mica. Such pigments are limited in terms of the reflected intensity, with the observed colour highly dependent on the orientation. Issues such as the need for a high pigment loading and difficulties in ensuring uniform planar deposition make them a niche and expensive alternative.

Technology. This new polymer-only colourant is comprised of structurally-coloured spherical microparticles that produce vibrant, fade-resistant and non-iridescent colour. The ‘microspheres’ comprise a concentric lamellar arrangement of a ‘bottlebrush block co-polymer’, which itself can be straightforwardly synthesized. By controlling the periodicity of this layered nano-structure the reflected colour is precisely controlled. Under diffuse illumination, e.g. sunlight, the particles appear to be uniformly-coloured, while strong direct illumination, e.g. a car headlamp, can result in angle dependent colour (i.e. iridescence).

Benefits of bottlebrush-based colourants.

- Scalable emulsion-based fabrication.
- The colour is intense, with up to 100% reflectivity from a single ‘microsphere’.
- The colour can be tuned across the entire visible spectrum.
- The colour is stable across a wide range of particle sizes and formulations.
- The colour can be made responsive to external stimuli, for e.g. colorimetric sensors.
- They can be used in coatings, producing iridescent, metallic or matte appearances.

Applications. Synthetic bottlebrush-based colourants offer a robust and scalable alternative to interference-based pigments. Potential applications range from automotive paints and coatings, to optical displays, sensors and security inks.

Next steps. This technology is protected by a GB patent application. We are seeking industrial partners to collaborate with us both on production and for specific applications. Please contact us to explore this opportunity.

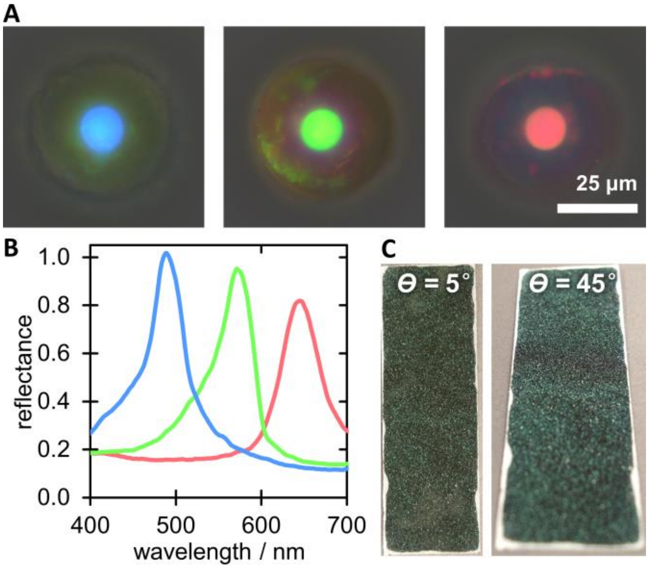

Figure A. Micrographs of individual blue, green and red microspheres.

Figure B. Reflectance spectra for the individual microspheres shown in Figure A, showing reflectivity up to 100% compared to a silver mirror.

Figure C. A film comprising <2wt% of green microspheres in a clear matrix. When viewed from low to high angles the reflected colour is unchanged.

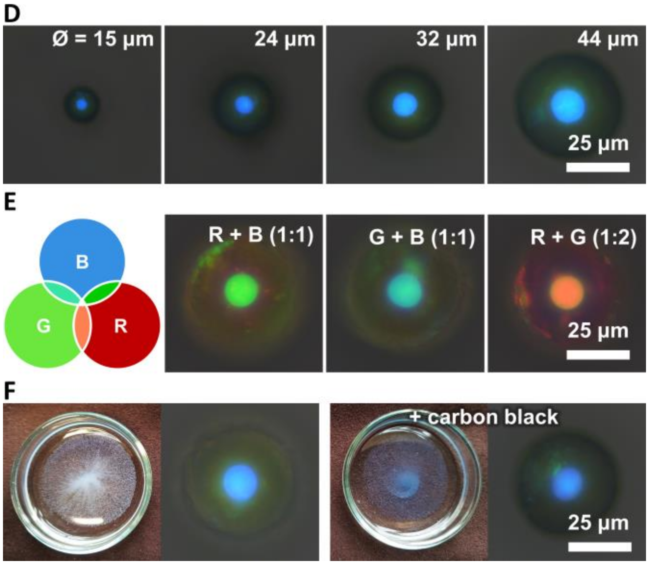

Figure D. The reflected colour is independent of the microsphere size.

Figure E. The reflected colour can be tuned through the initial polymer formulation to produce a wide spectrum of vibrantly coloured microspheres.

Figure F. Functional additives can be included; for example here carbon black is used to enhance the contrast.