

Construction of patterned Cu₂O photonic crystals on textile substrates

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Abstract:

The research on the construction of patterned photonic crystal structures on textile substrates using colloidal microsphere self-assembly method has attracted widespread attention. The photonic crystals constructed by colloidal microsphere self-assembly can exhibit bright structural colors with iridescent effects through interaction with light.

As a beneficial supplement to pigment coloring, structural coloration is increasingly developing as a new textile coloring technology. Starting from designing high refractive index inorganic metal oxide structural units, controllable and well-dispersed copper oxide (Cu₂O) nanospheres were prepared.

In this experiment, a two-step liquid phase reduction method was used to synthesize cuprous oxide single crystal sphere. Firstly, 0.32 g copper acetate, 0.52 g sodium citrate, 1.5 g polyvinylpyrrolidone (PVP), 30 g ethylene glycol and 100 g deionized water were added successively to a three-mouth round-bottom flask with a capacity of 250 mL. Then the flask was placed in a magnetic stirring constant temperature oil bath and stirred at 25 °C for 20 min. Dissolve 0.32 g of ascorbic acid in 15 mL of deionized water as backup, then slowly add 20 mL of 0.5 M sodium hydroxide solution and 7.5 mL of ascorbic acid solution, 5 min later add the remaining 7.5 mL of ascorbic acid solution, keep stirring during the process. The final mixed solution was gently stirred for 60 min and centrifuged with deionized water for 3 times to separate the product. After vacuum drying at 60 °C for 3 h, monocrystal solid spheres of different particle sizes can be prepared by changing the molar ratio of citrate to Cu²⁺. By optimizing parameters such as microsphere concentration and binder ratio, structural color printing pastes and inks were developed. These were then applied to construct patterned structural color photonic crystals on textile substrates using coating methods.

The Cu₂O nanospheres with different sizes were also applied onto fabrics, and structural colored fabrics with different colors were demonstrated, which are given in figure 1.

Keywords: Textile substrate, Structural color, Photonic crystals, High refractive index.

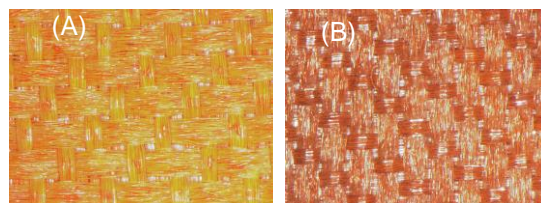


Figure 1 Structural colored textiles obtained from Cu₂O microspheres with different color (A) orange; (B) red

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