Unidirectional Light Propagation in Macroscopic Self-assembled Gain-Loss Nanomaterials (continuation)

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Assembled gain and loss nanoparticles can form a new class of materials with exceptional optical properties. Together with our colloidal self-assembly approach, current developments can provide a game changer for innovative applications such as superior laser manipulation, ultrasensitive, and noninvasive sensors. The key is to create an artificial symmetry breaking based on parity-time symmetry (PTS). This can be implemented by the analogy between the Schrödinger equation and the paraxial wave equation. Our strategy is to create a specific refractive index modulation with gain/loss colloids that allows unidirectional propagation of a light beam. Until now, the concept could only be implemented using top-down manufacturing techniques in limited spaces and at great expense. Using the directed self-assembly method, we can take the PTS concept a decisive step forward for future applications to create functional materials with exceptional optical properties. This scalable realization with photostable and solution-based nanoparticles can create a metamaterial that can be implemented on an industrial scale. In the first funding phase, we successfully demonstrated that we could self-assemble and analyze plasmonic or photoluminescent nanoparticles over large areas. This method development has decisively contributed to colloidal metasurfaces, which showed enhanced sensitivity, and improved charge carrier transport compared to conventional nanomaterials.
Our research group also established essential PTS prerequisites regarding refractive index profiles, loss/gain quantification, and modal coupling. However, the breakthrough in PTS detection is still pending experimentally. A critical evaluation of our methods has shown that our optical system still needs to be calibrated concerning the PTS effect. A key to the anticipated structures is that we use our established physicochemical methods to fabricate both bulk and colloidal PTS structures.

Projektbeteiligte

Priv.-Doz. Dr. Tobias Anton F. König
Leibniz-Institut für Polymerforschung
Dresden e.V.
Institut Physikalische Chemie und Physik Mi
der Polymere
Abt. Nanostrukturierte Materialien
Dresden