Nano-scale rings for optical applications

Berkeley DEEP TECH Innovation Lab

This patent outlines a technique for fabricating ring-shaped nanostructures using directed self-assembly (DSA) of block copolymers. When metallic nanoparticles are incorporated into the lattice of the rings, they have the ability to generate orbital angular momentum (OAM), an important optical property. These "nanorings" have potential applications in optical communications and AR/VR devices.

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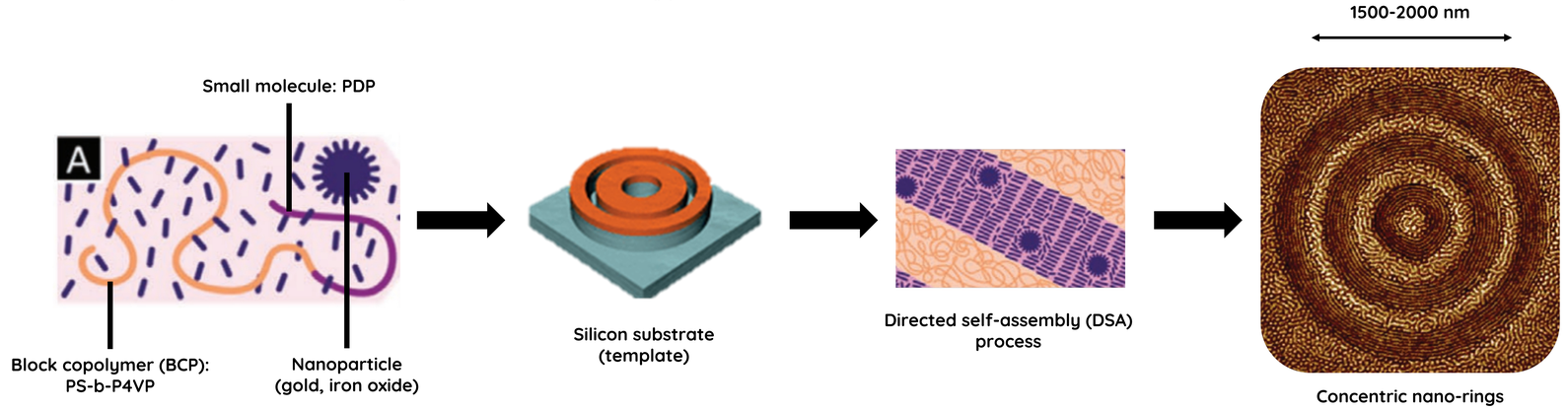
Background

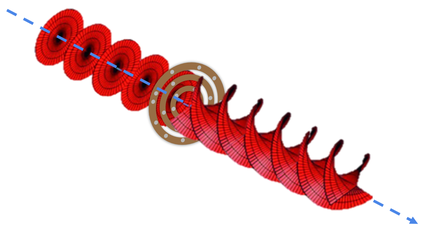
Directed self-assembly (DSA)

- This is a method patent, outlining a fabrication process for **concentric, ring-shaped nanostructures ("nanorings")**
- The electronegativity of BCP and PDP molecules cause them to **self-assemble into a stable lattice structure;** the lattice is guided by a silicon substrate
- When metal nanoparticles are integrated into the lattice, the nanorings have **important optical properties (details below)**



Optics

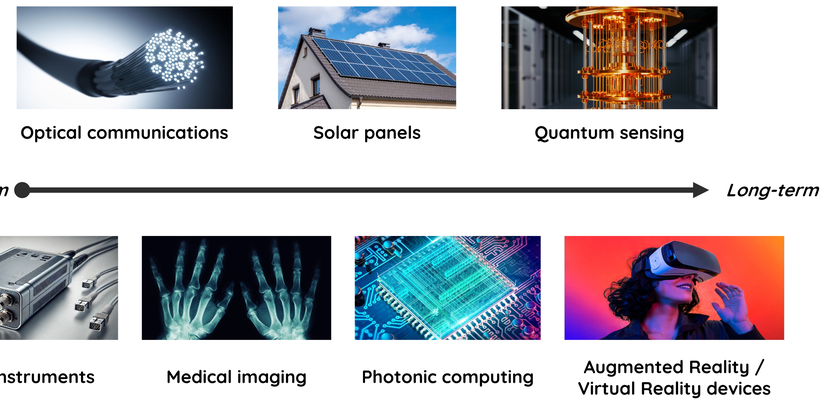
Orbital angular momentum (OAM)



- When a wave has OAM, the **wavefront's radial angle changes as it propagates through space;** thus, the wave is "spinning" like a coil or corkscrew
- Waves whose spin are phase-shifted **do not interfere;** thus, multiple beams can **propagate along a single axis**, allowing **many different streams of information** to be transmitted simultaneously

Potential Applications

Application areas vary by technological maturity



Deep Dive #1

Optical communications

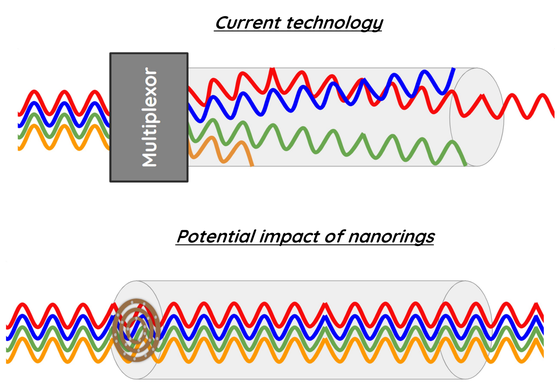
Techniques like **phase element coupling, fiber grating, optical coupling conversion, and photonic crystal fiber** are currently used to generate OAM

These methods introduce losses during mode conversion, **reducing signal power**

External devices or specialized fiber designs **complicate integration with fiber networks**

→ **Impact of nanorings:**

Can be easily integrated into optical fibers, **generating precise OAM modes directly, without the use of external converters**



Deep dive #2

Augmented Reality / Virtual Reality (AR/VR) devices

AR hardware must balance **performance** with **wearability**

→ **Impact of nanorings:**

- **Compact optical components** replace bulky systems
- Enables **sleeker and lighter designs**

Current AR lenses face issues like **limited field-of-view** and **chromatic aberrations**.

→ **Impact of nanorings:**

- Nanorings can **enhance light bandwidth** for clearer display visuals
- Improved light manipulation efficiency **minimizes distortions and energy loss**