Photonic Platform for Polarization Diversity and Extremely Broad Bandwidths

New platform enables polarizers to span optical bandwidths of more than an octave in frequency

(Note: figures referenced below can be found by clicking the Image Gallery, to the right.)

UCF researchers have invented a breakthrough technology for creating optical systems that enable control of different polarizations over broader bandwidths than those of conventional systems. The innovative polarization-diverse photonic platform allows manufacturers to separate, filter or manipulate light, depending on its polarization and to integrate different polarization functionalities onto a single substrate (chip). For example, one layer of a device can run “transverse-electric-only” (TE) and “transverse-magnetic-only” (TM) single-polarization waveguides as well as conventional waveguides that support both polarizations.

Polarization management is critical to today’s state-of-the-art integrated photonic systems. However, devices, such as polarizers and polarization beam splitters (PBS), only support a few optical bandwidths, limiting their use in sensing and wideband frequency conversion. Achieving polarization diversity is expensive, extremely complicated, and requires lengthy processing that usually includes bulky, fiberized components. In contrast, the UCF invention offers a low-cost solution for making compact, reliable integrated chips that can manage polarization over bandwidths of more than an octave in frequency while minimizing losses and conserving chip area. The invention also facilitates the development of new devices, such as a “polarization-cloaked resonator” (shown in Figure 1), which is ideal for applications that require spectral filtering of one polarization.

Technical Details

The invention consists of a unique arrangement of optical materials on a substrate and fabrication methods that enable precise and spatially variable control over the refractive index of light with different polarizations. By exploiting both optically anisotropic and isotropic materials, the invention allows manufacturers to achieve greater optical bandwidths in devices such as polarizers and PBS.

Aspects of the invention use a fundamentally different technique for performing polarization-selective operations on integrated photonic channels. In one example use of the invention, both TE and TM polarizers can be implemented together instead of separately, and require no further processing, compared to the usual fabrication flow. In some cases, because of the high degree of symmetry in a structure and its wavelength-independent operation, bandwidths can span beyond an octave—a landmark improvement over conventional devices.

A key feature of the invention is that it accommodates a wide variety of materials to create an assortment of wave-guiding devices. For example, in Figure 2, films A-D and Substrate/...
Handle Wafer can consist of either dielectric or semiconductor materials, or a combination, and can include silicon-based compounds such as amorphous silicon, silicon dioxide and silicon nitride. In principle, any dielectric materials are acceptable for films A-D, as long as their combination satisfies the refractive index relationships identified in Figure 3.

Benefits

- Enables broader-bandwidth polarization diversity while minimizing losses and saving chip area
- Yields very high-performance, extremely broadband polarization-selective photonic devices
- Uses simple, reliable deposition and etching methods that are well-established in the industry

Applications

- Telecommunications
- Aerospace
- Remote optical sensing and spectroscopic analysis

Technology #33645


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