Arrayed Waveguide Gratings: Design and Applications

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Abstract: The Arrayed Waveguide Grating (AWG) is a passive optical component widely employed in optical network systems, sensing and medical diagnostics, including applications in medical imaging and spectroscopy. AWGs can be categorized into two primary types based on the material index contrast: low-index contrast AWGs (e.g., silica-on-silicon (SoS)-based waveguide devices) and high-index contrast AWGs (e.g., silicon, silicon nitride, or polymer-based waveguide devices). Low-index contrast AWGs are characterized by low fiber coupling and propagation losses, offering significant advantages in the implementation of Dense Wavelength Division Multiplexing (DWDM) systems for multiplexing and demultiplexing, thereby enhancing the transmission capacity of modern optical communication networks. In contrast, high-index contrast AWGs feature compact footprints due to the larger refractive index difference between the waveguide core and cladding. These devices are particularly suited for on-chip integration and are being deployed in emerging technologies such as optical sensors, DNA diagnostics, and optical spectrometers for infrared spectroscopy.

This paper presents a comprehensive review of the AWG functionality, design principles, optimization strategies, and technological advancements of AWGs. We will present the various AWG designs and discuss their diverse applications in fields such as telecommunications, sensing, and optical coherence tomography.

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