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Performance Comparison of Anti-Calling Properties of Arrayed Waveguide Gratings and Traditional Cables

Overview

Design, fabrication and characterization of arrayed waveguide grating. We successfully fabricated the proposed AWG devices which have the characteristics.

Key Takeaways

Arrayed waveguide gratings (AWGs) generally offer superior anti-crosstalk performance compared to traditional cables, with crosstalk levels as low as 19–27 dB and insertion losses below 2 dB.Anti-Crosstalk Performance

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AWGs are designed to separate optical signals into multiple wavelength channels with high precision. Crosstalk in AWGs arises from interference between adjacent waveguides, but modern designs, including S-shaped and high-contrast silicon-on-insulator (SOI) AWGs, achieve crosstalk as low as 19 dB while maintaining insertion losses below 2 dB . Regular AWGs typically exhibit crosstalk around 27 dB, which is still superior to many traditional cable systems . The planar integration and precise path-length control in AWGs allow for high spectral resolution and minimal signal leakage, making them highly effective in dense wavelength-division multiplexing (DWDM) applications . Traditional cables, such as copper or standard optical fibers, rely on physical separation and shielding to reduce interference. While fiber optics inherently have low crosstalk, conventional multi-core or bundled cables can suffer from inter-core interference and electromagnetic coupling, especially over long distances or in high-density deployments. Unlike AWGs, traditional cables lack the ability to actively manage phase differences or precisely control signal dispersion, which limits their anti-crosstalk performance in complex multiplexing systems.

Advantages of AWGs

• High fabrication tolerance: AWGs are more robust to manufacturing imperfections compared to planar echelle gratings, reducing phase errors that can degrade signal isolation .

• Compact integration: Modern AWGs can be 70 times smaller than traditional designs, reducing phase errors and improving overall performance .

• Customizable spectral response: AWGs can be tailored for low crosstalk, flat-top transmission, or high-resolution applications, providing flexibility for telecommunication, spectroscopy, and medical imaging .

• Low insertion loss: Typical AWG designs maintain insertion losses below 2 dB, ensuring minimal signal degradation .

Limitations of Traditional Cables

• Limited control over signal interference: Crosstalk depends on physical separation and shielding, which may be insufficient in high-density or high-speed systems.

• Larger footprint for high channel counts: Increasing the number of channels in traditional cable systems often requires more complex routing and shielding, which can increase losses and interference.

• Less adaptability: Unlike AWGs, traditional cables cannot dynamically adjust to wavelength-specific interference or phase errors.

Conclusion

In terms of anti-crosstalk properties, AWGs outperform traditional cables due to their precise waveguide design, low insertion loss, and high fabrication tolerance. They are particularly advantageous in high-resolution, multi-channel optical systems, whereas traditional cables are more suitable for simpler, lower-density applications where extreme crosstalk suppression is not critical .

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Article Content

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