



## A Review of Subwavelength Grating Waveguide Bragg Gratings for Optical and Microwave Photonic Signal Processing

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Integrated waveguide Bragg gratings (WBGs), like their fiber Bragg grating counterparts, have numerous applications for optical and microwave photonic signal processing [1]. For example, they can be used as filters, resonators, and spectral shaping devices, as well as to provide specific phase or group delay characteristics. A common approach to develop integrated WBGs, especially in silicon-on-insulator (SOI), is to use sidewall corrugations. Recently, subwavelength gratings (SWGs) have attracted significant interest as a means for developing integrated metamaterial waveguide devices in SOI [2,3]. It is also possible to implement Bragg structures in SWG waveguides [4,5]. In this paper, we review recent work on developing SWG WBG devices, including (1) high-Q resonators based on wideband phase-shifted structures [6,7], (2) multi-wavelength filters based on sampling, (3) dispersive elements using step-chirped and continuously chirped designs [8], and (4) tunable polarization dependent responses using tilted SWG planes [9]. We also discuss applications of the various devices for optical and microwave photonic signal processing.

1. M. Burla, L. R. Cortés, M. Li, X. Wang, L. Chrostowski, and J. Azaña, “Integrated waveguide Bragg gratings for microwave photonics signal processing,” *Optics Express*, **21**, 21, October 2013, pp. 25120-25147.
2. P. Cheben, R. Halir, J. H. Schmid, H. A. Atwater, and D. R. Smith, “Subwavelength integrated photonics,” *Nature*, **560**, August 2018, pp. 565-572.
3. J. Manuel Luque-González, A. Sánchez-Postigo, A. Hadji-ElHouati, A. Ortega-Moñux, J. Gonzalo Wangüemert-Pérez, J. H. Schmid, P. Cheben, I. Molina-Fernández, and R. Halir, “A review of silicon subwavelength gratings: building break-through devices with anisotropic metamaterials,” *Nanophotonics*, **10**, 11, August 2021, pp. 2765-2797.
4. L. R. Chen, J. Wang, B. Naghdi, and I. Glesk, “Subwavelength grating waveguide devices for telecommunications applications,” *IEEE Journal of Selected Topics in Quantum Electronics*, **25**, 3, May/June 2019, 8200111.
5. J. Čtyroký, J. Gonzalo Wangüemert-Pérez, P. Kwiecien, I. Richter, J. Litvik, J. H. Schmid, I. Molina-Fernández, A. Ortega-Moñux, M. Dado, and P. Cheben, “Design of narrowband Bragg spectral filters in subwavelength grating metamaterial waveguides,” *Optics Express*, **26**, 1, January 2018, pp. 179–194.
6. H. Sun and L. R. Chen, “Phase-shifted waveguide Bragg gratings enabled by subwavelength grating structures,” *Optica Advanced Photonics Congress*, 26-29 July 2021, paper IM2A.4.
7. H. Sun and L. R. Chen, “Wideband apodized phase-shifted subwavelength grating waveguide Bragg grating,” *IEEE Photonics Conference*, 18-21 October, paper MD2.2.
8. H. Sun, Y. Wang, and L. R. Chen, “Integrated discretely tuneable optical delay line based on step-chirped subwavelength grating waveguide Bragg gratings,” *IEEE/Optica Journal of Lightwave Technology*, **38**, 19, October 2020, pp. 5551-5560.
9. H. Sun and L. R. Chen, “Polarization-dependent tuning of Bragg reflection enabled through tilted subwavelength grating waveguide Bragg gratings,” *Optics Letters*, **46**, 6, March 2021, pp. 1450-1453.