

microwave drive signal. Moreover, if the two LCFBGs are written in Er/Yb co-doped fibers, the dispersion of the FBGs can be continuously tuned through optical pumping. When the optically pumped LCFBGs are incorporated in the unbalanced TPS system, photonic generation of a frequency tunable microwave waveform can be achieved [71].

4. Summary

FBGs and their applications for microwave photonic signal processing and photonic generation of microwave arbitrary waveforms have been discussed. In general, an FBG in a microwave photonic subsystem can serve as 1) a time-delay device; 2) a narrow-band optical filter; 3) a dispersive element; and 4) a broadband optical spectral shaper. The key advantages of using FBGs for microwave photonics applications include small size, low loss, low cost, and high compatibility with other well-developed fiber-optic devices.

Compared with microwave photonics systems based on free-space optics, FBG-based systems have the limitation of poor reconfigurability since the spectral response of an FBG can be hardly changed once fabricated. The techniques for FBG tuning are mainly based on mechanical [72] and thermal tuning [41], at a very low tuning speed. An improved tuning speed can be achieved with the use of a piezoelectric device [73] or a divided thin-film heater [74]. Further improvement in tuning speed can be achieved by electrical [75] or magnetic [76] tuning.

While FBG devices are cheap, microwave photonics systems based on fiber-optic devices are still costly due to the use of discrete optical devices, such as high-speed electro-optical modulators and photodetectors. A solution to reduce the system cost, weight, footprint size and power consumption is to use photonic integrated circuits (PICs) [77]. Investigation of on-chip microwave photonics subsystems using the PIC technique would be a future research direction in this field. Bragg gratings with the desired spectral characteristics can be incorporated in an on-chip microwave photonics system by writing waveguide Bragg gratings. Research attempts to develop waveguide Bragg gratings have been reported [78–80]. For instance, photonic time delay lines have been implemented using integrated Bragg gratings in silicon-on-insulator (SOI) rib waveguides, which can be tuned by either electrical [78] or thermal [79] tuning. Waveguide Bragg gratings have also been demonstrated for photonic signal processing, such as ultrafast all-optical temporal differentiation [80].

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