Microwave Photonic Notch Filters using Stimulated Brillouin Scattering in Silicon Nitride Waveguides

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We present two stimulated Brillouin scattering based microwave photonic notch filters in silicon nitride. We report a rejection up to 60 dB and a 3 dB bandwidth down to 400 MHz.

We have recently shown that we can create acoustic guidance in silicon nitride waveguides [1]. These waveguides are made using the symmetric double stripe (SDS) geometry, which consists of two silicon nitride layers of the same thickness [2]. Because these waveguides have emerged as a strong platform for microwave photonics [2], they are a good candidate for integrating stimulated Brillouin scattering (SBS). We use the SBS gain in our 1.4 µm wide SDS waveguide to create an RF notch filter using two different techniques, both of which use the principle of destructively interfering optical sidebands.

The first method, schematically shown in Fig. 1a, relies on an in-phase quadrature (IQ) modulator [3]. The RF input (I) is modulated onto an optical carrier creating two sidebands of opposite phase and unequal amplitude (II). SBS amplification then equalizes the amplitude of the sidebands at the desired frequency (III), which when mixed on a photodiode results in an RF notch (IV). The resulting notch filter, with a 3 dB bandwidth of 400 MHz and a rejection of 30 dB is depicted in Fig. 1b.

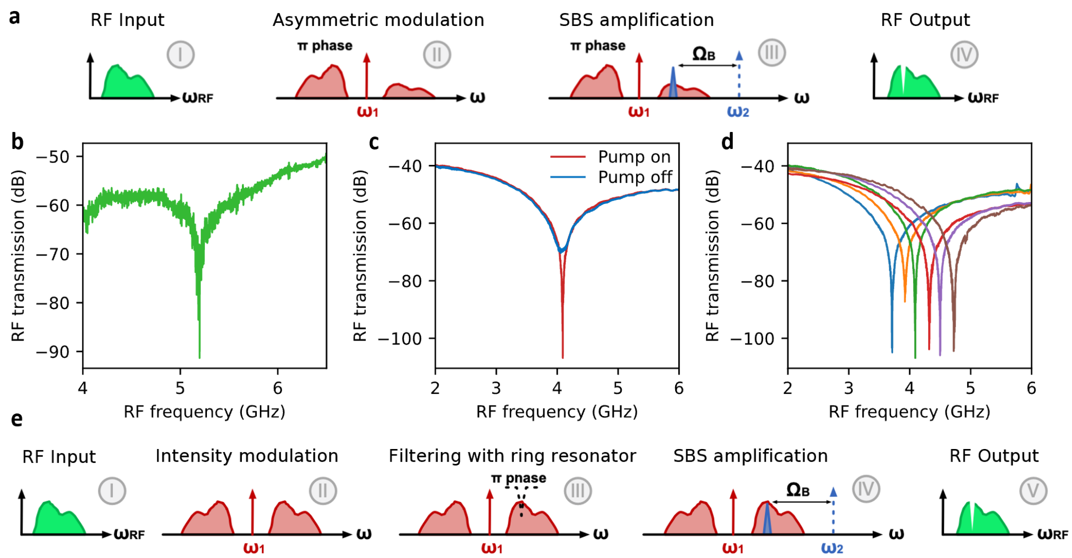

Fig. 1: **a** The working principle of the IQ modulator based filter. **b** The RF notch created with the IQ modulator based filter. **c** The RF notch filter created with the ring resonator based filter, showing the effect of the SBS pump laser. **d** Central frequency tuning of the ring resonator based filter. **e** The working principle of the ring resonator based filter.

The second method, schematically shown in Fig. 1e, creates a notch by combining a ring resonator with the SBS gain [4]. The RF input (I) is intensity modulated onto an optical carrier. An over-coupled ring resonator creates a shallow notch with π phase shift onto the upper sideband (III), and the SBS gain compensates the loss in amplitude (IV). Mixing on a photodiode results in an RF notch (V). We use a ring made from a standard 1.2 µm wide SDS waveguide to create this filter, which is depicted in Fig. 1c. This also shows the effect of the SBS compared to just the ring response. The center frequency of this filter can be tuned, as shown in Fig. 1d. This filter is readily integrable, as it is based on one platform.

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References

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