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The random fiber lasers and their applications

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Random fiber lasers (RFLs) with unique frequency and phase properties have attracted much attention. Comparing with the fixed cavity length lasers, RFLs rely on a scattering medium, where multiple scattering lights due to spatial inhomogeneity is captured by the fiber waveguide and amplified through different gain media leading to one-dimensional lasers with good directionality. The frequency, phase and intensity noises of RFLs have strong dependency on the free mean length (Δl) of the scattering medium. Through our experiments, we observed three different cases relative to the fiber length L, wavelength λ: (1) when $\Delta l > \lambda$, the frequency jitter is the highest, although relative intensity noises (RIN) and the linewidth (<5 kHz) is comparable to the phase locked laser. The random feedback can be realized by writing random grating at sub-mm spacing; (2) when $\Delta l \sim \lambda$; the linewidth can be <100 Hz with long fiber ($L \geq 5$ km), RIN is increased due to large number of the random modes, while the frequency noise is reduced; (3) $\Delta l < \lambda$, the RIN and frequency noise are the lowest, and the linewidth is ~10 Hz, which can be used as reference for laser linewidth characterization. The gains of the RFLs are: Er-doped fiber (EDF), Brillouin and Raman amplification and SOA. The high RIN in RFLs can be used for the random number generators (RNGs) at high speed (MHz to GHz). The distributed feedback allows multiple wavelengths operation in the laser without phase matching condition of $2\pi m$ (m is integer) constraint in the wavelength selection, and hence it can be used as tunable microwave generator. For the Brillouin scattering, the random mode injection acts as the mode selection element, which allows single mode operation and high order Brillouin frequencies with the high contrast and narrow linewidth (1 kHz). The random gratings can be used as random feedback and sensing head to achieve high sensitivity thanks to the lasing gain for large dynamic range. The temperature, strain and refractive index and ultrasound sensing has been demonstrated.

Biography

Xiaoyi Bao is the Canada Research Chair Professor (Tier I) in Fiber Optics and Photonics in Center for Research in Photonics, Physics Department, University of Ottawa, Canada. Her research interests range from study of nonlinear effects in fibers to make fiber device, lasers and sensors. She has co-authored over 260 refereed journals and 210 conference proceeding papers, 9 book chapters, and 6 IPs/patents from her group have been transferred to industries. She is a Fellow of Royal Society of Canada (RSC), OSA and SPIE.

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