Exploring New Ultrafast Operation Regimes in Quantum Dot Lasers and Amplifiers

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Abstract: We will present our recent results, harnessing the flexibility of quantum dot materials towards the development of increasingly versatile regimes of ultrashort pulse generation and amplification in edge-emitting devices.

This talk will cover some of our recent research in novel operation regimes in ultrafast quantum-dot amplifiers and lasers. Quantum-dot based materials have shown a wide range of advantages for ultrafast photonic components [1,2], such as broadband gain and absorption, as well as ultrafast carrier dynamics - which by consequence underpins short absorption and gain recovery times.

We will present results showing how we have harnessed these advantages to demonstrate double-pass amplification of picosecond pulses [3], resulting in up to a 4-fold enhancement of output power with minimal increase in the pulse duration of the seed pulses, when compared to the equivalent single-pass amplification scheme (both depicted in Fig. 1). At the core of this amplification process is a two-section tapered semiconductor optical amplifier based on InAs/Gas quantum dots. This tapered device is indeed a versatile component and its performance as a stand-alone superluminescent diode was previously reported in [4]. The same device also revealed a wide and tunable spectral asymmetry between narrow and wide facets, which was enabled by the injection of different current densities in the two sections, leading to a non-uniform filling of the confined states in the quantum dots – a phenomenon with implications for amplifiers and the setup of external cavity lasers using such devices [5]. A similar tapered device was also previously used as a building block for a high-power broadly tunable external-cavity quantum-dot laser [6]. In this talk, we will also present recent results obtained on pulse generation from quantum-dot lasers [7,8].

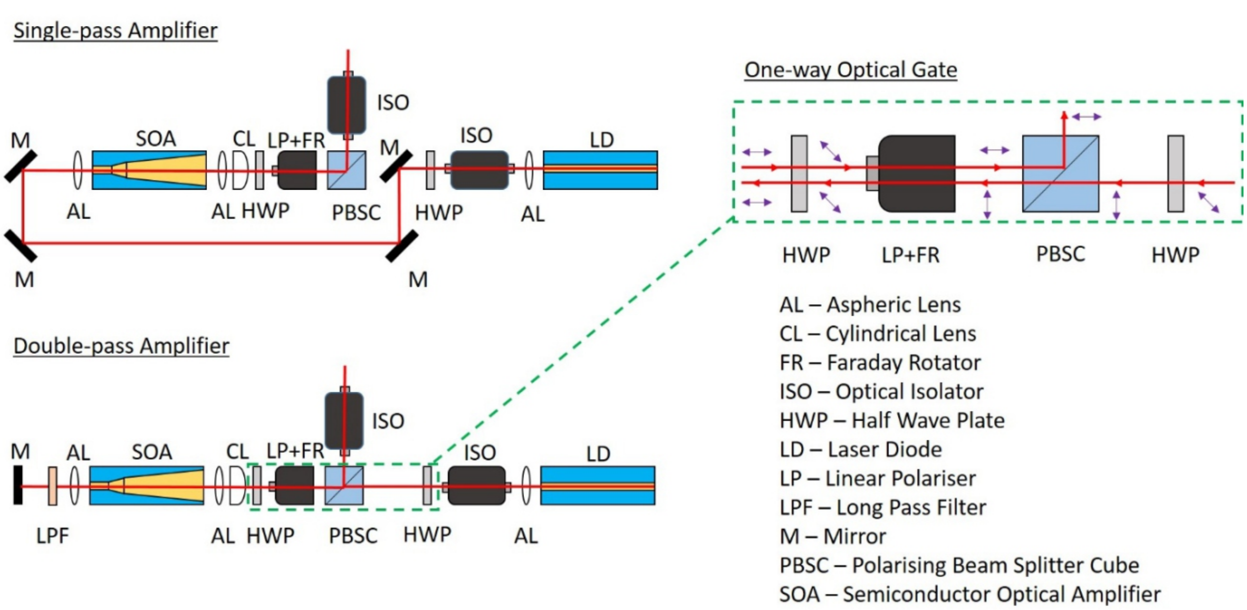

Fig. 1. Schematic diagrams of the single-pass and double-pass amplifier schemes. Reproduced from [3].

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