Novel Synchronous Time-domain Spectral Phase Encoding/Decoding Scheme for Secured Optical Communication

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Rapid reconfiguration of optical codes (OCs) can significantly enhance the confidentiality of coherent optical code division multiple access (OCDMA) system [1]. However, most of conventional OCDMA encoding/decoding schemes do not have this capability. Recently, a fast reconfigurable time domain spectral phase encoding (SPE) scheme, which has this capability, has been proposed using high speed phase modulator and arrayed waveguide grating (AWG) decoder [2]. In this paper, we propose a novel synchronous time-domain spectral phase encoding/decoding (SPED) scheme for secured optical communication.

Figure 1 shows the schematic diagram of the proposed scheme. The pulse generator generates short optical pulses at data-rate, the SPE consists of a pair of dispersive components with opposite dispersion values (+D and –D) to stretch/compress the optical pulse and a phase modulator (PM) or a hybrid intensity/phase modulator (IM/PM) for data and OC modulation. The spectral phase decoding (SPD) is similar to the SPE with a PM synchronously driven by OC (the complementary pattern of OC) at a repetition rate equal to the data-rate. The OCs thus can be rapidly reconfigured even bit-by-bit to enhance the system confidentiality.

A proof-of-principle experiment was carried out to demonstrate the proposed scheme. A 1.5 ps optical pulse train with central wavelength of about 1552.52 nm was generated at 1.25 GHz repetition rate using a mode-locked laser diode (MLLD) and an IM. The stretching/compressing components are a piece of reverse dispersion fiber (RDF) and a span of single mode fiber (SMF) with +/- 312.5 ps/nm dispersion, respectively. Therefore after stretching the optical pulse one bit duration of 800 ps covers 2.56 nm (320 GHz) spectral range. To simply the experiment, we neglected the pair of dispersive components between the two PMs of SPE and SPD, which gives only zero dispersion overall. The OCs were 8-chip, 100 ps/chip (10GHz/chip) binary phase shift keying (BPSK) code patterns and the PMs were driven by these patterns with repetition rate of 1.25 GHz in the SPE and SPD. We tried 5 different OC patterns in the experiment OC1–OC5: (11101000), (11100100), (11010101), (10101010) and (11001100). Figure 2 (a)–(c) show the auto-/cross-correlations of OC1–OC3. The auto-correlations for the three patterns have well defined needle shape with pulse-width of 3.0ps, 2.7ps and 3.0ps, respectively. The generated pulse is broader than the original ones mainly because of the distortion of the spectra after the SPD as shown in the insets. The contrast ratios between auto-/cross-correlation peaks are 2.65, 2.77 and 2.25, respectively. Employing PMs with better performance may improve this in future. We further carried out a pseudo random bit sequence (PRBS) data transmission experiment using an IM. The BER performance is shown in Fig. 2(d). Error free has been achieved with all the three code patterns.

In summary, the feasibility of the proposed synchronous SPED scheme has been successfully demonstrated in the experiment. This technique provides a new approach for secured optical communication system.

References