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Advanced fiber grating devices fabricated for all-optical signal processing

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A fiber grating is an optical fiber for which the refractive index in the core has a periodic or quasi-periodic perturbation profile. Fiber gratings can be created with various laser sources such as UV lasers (photosensitivity is required) and femto-second lasers (no photosensitivity is required). Fiber grating technology has attracted considerable research interests in past two decades since it has wide applications in optical communications and sensing. Due to their natural compatibility, fiber gratings can serve as a perfect platform for all-optical signal processing in optical fiber communication systems. They can directly process optical signals in optical fiber without the need for coupling/re-coupling alignments required by bulk-optics or chip based devices, thus provide a low-loss, stable, cost-effective and ultra-fast solution for optical signal processing. Moreover, they can offer very strong design flexibility to achieve almost arbitrary spectral characteristics. Here we will report our recent progress on all-optical signal processing based on fiber grating technology. We will present fiber gratings designed and fabricated for optical differentiation, optical pulse shaping, optical format conversion and so on. The gratings were designed with layer-peeling method and fabricated with UV direct-writing technique. The performances of their use as optical signal processors were also evaluated experimentally.

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Optical spectroscopy in photodynamic therapy for superficial skin malignancies and actinic keratosis

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Photodynamic therapy is a non-invasive therapy for non-melanoma skin cancer. Photodynamic therapy involves the activation of a photosensitizing drug by visible light to produce activated oxygen species within target cells, resulting in their destruction. In addition to its therapeutic uses, optical spectroscopy is a helpful tool to prove the efficacy of PDT. It provides information on the distribution and degradation of sensitizers at the tumor's treatment area, the formation of fluorescent photoproducts, changes in tissue auto fluorescence, light absorption and scattering in tissue induced by photodynamic treatment. In this project photodynamic therapy (PDT) with topical application of methyl 5-aminolevulinate was used to treat non-melanoma skin cancer and actinic keratosis. The interval between the photosensitizer application and illumination was 3 hours. The incident light dose was mostly 75 J cm−2, at ~635 nm wavelength. An imaging system was used to monitor spectroscopic signals during the PDT of tumors to display the localization and extension of skin tumors and to check therapy effectiveness.The spectra were classified and compared to histopathology to evaluate the efficiency in diagnostic discrimination employing optical spectroscopic techniques. Our findings indicate the potential of combination of PDT and spectroscopy as a reporter of treatment outcome. Further work is under way, in order to establish optimal treatment schemes.

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