2D Materials Enhance Optical Fibers

2D materials can be used to coat optical fibers to enhance non-linear interactions opening new ways for building future non-linear and ultrafast laser systems. NIR and SWIR spectroscopy measures and quantifies the output properties and optical behaviour

Atomically thin **2D materials** such as graphene and **transition metal dichalcogenides (TMDs)** can be used to coat other materials to increase their functionality and also to better utilize their optical properties. A research team around Zhongfan Liu from the Chinese academy of Sciences and Peking University in China describe in a recent publication in Nature Nanotechnology how they can enhance the use of non-linear properties of 2D materials in optical fibers. Their approach can be applied to a wide range of materials and fiber designs, opening up new possibilities for 2D material enhanced lasers and light conversion systems.

The team grows the TMDs MoS2 onto silica fibers by **chemical vapor deposition** processing and use **Raman and PL spectroscopy** to show the high uniformity and quality of the 2D material layer (both are fundamental characterization techniques for all 2D materials).

Due to their atomically thin structure the thin films do not negatively affect the optical modes in the fibers and by interaction throughout the length of the fiber, the non-linear effects can be greatly enhanced. The experiments show enhancements of up to 300x for second (SHG) and third harmonic generation (THG) at 900 nm and 700 nm from pump beams at 1800 nm and 2100 nm. The researchers also build a mode-locked laser at telecom wavelength with pulse width as short as 200 fs where MoS2 is used as the saturable absorber using an all fiber design without freespace optical parts.

Both experiments use optical spectroscopy. The second and third harmonic generation is monitored by an **SP2500** spectrograph with detection by a **Pylon-400BRX deep depleted spectroscopy camera**. Using a deep depleted sensor broad spectral coverage with particular high sensitivity in the NIR wavelength range can be achieved. The measurements confirm the presence of the harmonic signal by monitoring the wavelength of the signal and quantifies the amplification enhancement as function of input power and fiber length. The output of the mode-locked laser in the SWIR wavelength range at 1550 nm is measured using an **HRS-300 spectrograph and NIRvana-640 InGaAs camera.**

Based on their measurement results the researchers conclude that “the superior performance, massive production ability and environmental adaptability of the MoS2-embedded fibre demonstrate its distinct advantages compared with a conventional 2D-materials-integrated fibre on the facets or external surfaces, indicating that it is ready for scientific research and industrial applications in ultrafast lasers.” As their methods are applicable to different fiber designs and other 2D materials, new designs for fiber lasers with 2D material enhancement can be expected in the future.

Publication: Optical fibres with embedded two-dimensional materials for ultrahigh nonlinearity, Nature Nanotechnology (2020)

Researcher: Zhongfan Liu, Beijing (China)

Related Products: HRS, Pylon, NIRvana