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355 nm-laser pumped hydrogen UV Raman comb

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Ultraviolet (UV) laser sources are of great interest in a large number of applications such as spectroscopy, bio-medicine, gas detection, water and food decontamination to cite a few. Unfortunately, the covering of this range of wavelengths is tedious due to the lack of gain media that combine, compactness, high power levels and emission at wavelengths lower than 300 nm. Hitherto, the existing UV laser sources are usually cumbersome, short-lived and cover a limited number of wavelengths.

Here we propose a multiple wavelength Raman-comb source based on a frequency-tripled micro-chip laser pumped hydrogen-filled hollow-core photonic crystal fiber (HCPCF) to overcome these shortcomings. Whilst, broad Raman spectra have been already been demonstrated, however, the generated Raman combs were limited in spectral components or optical spectral density in the UV [1].

Figure 1 the measured output spectrum of this HCPCF based Raman source, and which exhibits no less than 20 Raman lines in the range 250 nm to 400 nm.

The result was achieved using a UV low transmission loss inhibited coupling (IC) HCPCF. The fiber shows a tubular design cladding composed of 8 tubes and a core diameter of 27 μm . It exhibits optical overlap between the cladding mode and the core mode of only $\sim 10^{-6}$, thus enabling in principle to solve the problem of solarization effect [2]. The measured transmission were found to be beneath a 100 dB/km level in the UV with transmission observed down to 230 nm. This leads to the possibility of generating a Raman comb in the UV by directly pumping a HCPCF with a microchip laser at 355 nm. The fiber has then been filled with hydrogen gas with a pressure that can be monitored and sealed in order to generate a Raman comb optimized for the UV. The energy of the laser pump was set at the maximum of 15 μJ and coupled in this system with an efficiency superior to 85%. A systematic study has been performed by playing on the fiber length and on the pressure of the hydrogen in order to optimize the UV components of the spectrum. The optimum fiber length is found to be 120 cm with a hydrogen pressure of 2 bars. The resulted Raman comb covers 4 lines in the UV-C, 8 lines in the UV-B and 9 lines in the UV-A if we include the pump. The total energy was measured to be 12.5 μJ with high spectral densities, ranging from 4 $\mu\text{W}/\text{nm}$ at 269 nm to 4 mW/nm at 362 nm.

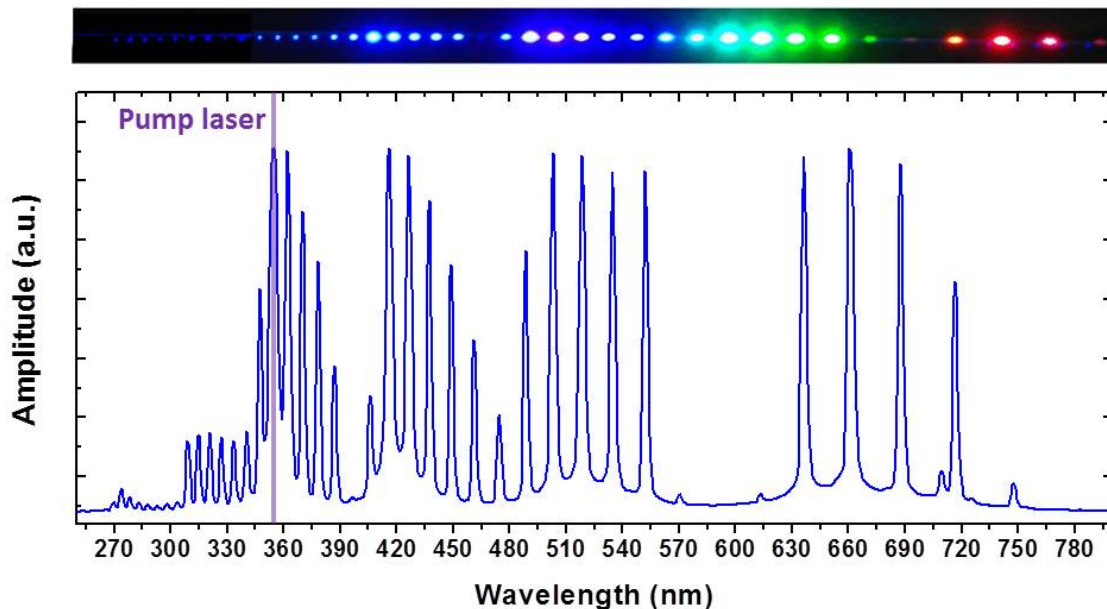


Fig. 1 Picture and spectrum of the Raman comb generated in 120 cm fiber filled in with 2 bars of hydrogen pumped by a microchip laser at 355 nm.

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