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Title: Generation of UV Light from Microstructural Fibers Pumped with a Femtosecond 800 NM Oscillator

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Generation of UV light from microstructured fibers pumped with femtosecond 800 nm oscillator

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Abstract: Generation of wavelengths up to 310 nm from the multimode microstructured fiber pumped with 1 W of 800 nm is demonstrated. The nonlinear mechanism is distinct from the supercontinuum generation. The efficiency depends strongly on the input polarization and fiber tip morphology.

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Microstructured fibers have been shown to be an excellent media for nonlinear optical interactions due to small core size, long interaction length and unusual dispersion properties. Supercontinuum generation with just oscillator pumping is one of the manifestations of such properties [1]. The supercontinuum is typically observed in the fundamental mode even in the multimode PCFs. Another interesting observation is the generation of distinct frequency bands when pumping the PCF at 1550 nm [2]. The color generation was observed in the visible region exiting the fiber in single higher-order modes different for each color.

Here we report the observation of the upconversion of the femtosecond 800 nm pulses from a commercial Ti:Sapphire oscillator to the UV frequency range, Fig. 1. It is unambiguously observed that the nonlinear mechanism is distinct from that of the supercontinuum generation and the UV generation occurs starting from the higher-order mode at the fundamental wavelength and yielding a very high-order mode in the UV.

The experiment involves a Spectra Physics Tsunami, 150-fs laser delivering up to 1.3 W to the fiber. After the attenuator, Faraday isolator and polarization control optics, the light is focused on the tip of the PCF with an aspheric lens. The fiber was a high-air-filling fraction single strand fused silica suspended by a honeycomb web of silica pellicles running along the length of the fiber, which was a few tens of centimeters in our experiments. The diameter of the core was approximately 2.5 microns which makes the fiber highly multimode at 800 nm.

It was observed that upon increasing the power of the fundamental input to a freshly cleaved fiber, a strong supercontinuum was generated. When further increasing the power, however, one reaches a threshold (1.1 W in our case) when the supercontinuum suddenly ceases and a strong UV light emerges from the fiber in high-order multilobe modes, Fig. 2. The threshold of the supercontinuum cessation was later identified with the change of the fiber core tip morphology as revealed by the transverse scans shown in Fig. 3 and SEM images (shown in the inset of Fig. 3 only for freshly cleaved fiber).

The efficiency of the UV generation was found to be strongly dependent on the polarization of the fundamental and varied between experiments. These findings strongly suggest that launching the fundamental light into a higher-order mode was critical for the process. The aforementioned threshold corresponds to the melting of the fiber tip after which the tip is no longer flat but rather works as a phase mask for the coupling of the input light. Such a mask decreases the efficiency of the fundamental mode excitation leading to the disappearance of the supercontinuum and increases the efficiency of higher-mode excitation which results in the UV generation through phase matching to even higher-order modes.

References

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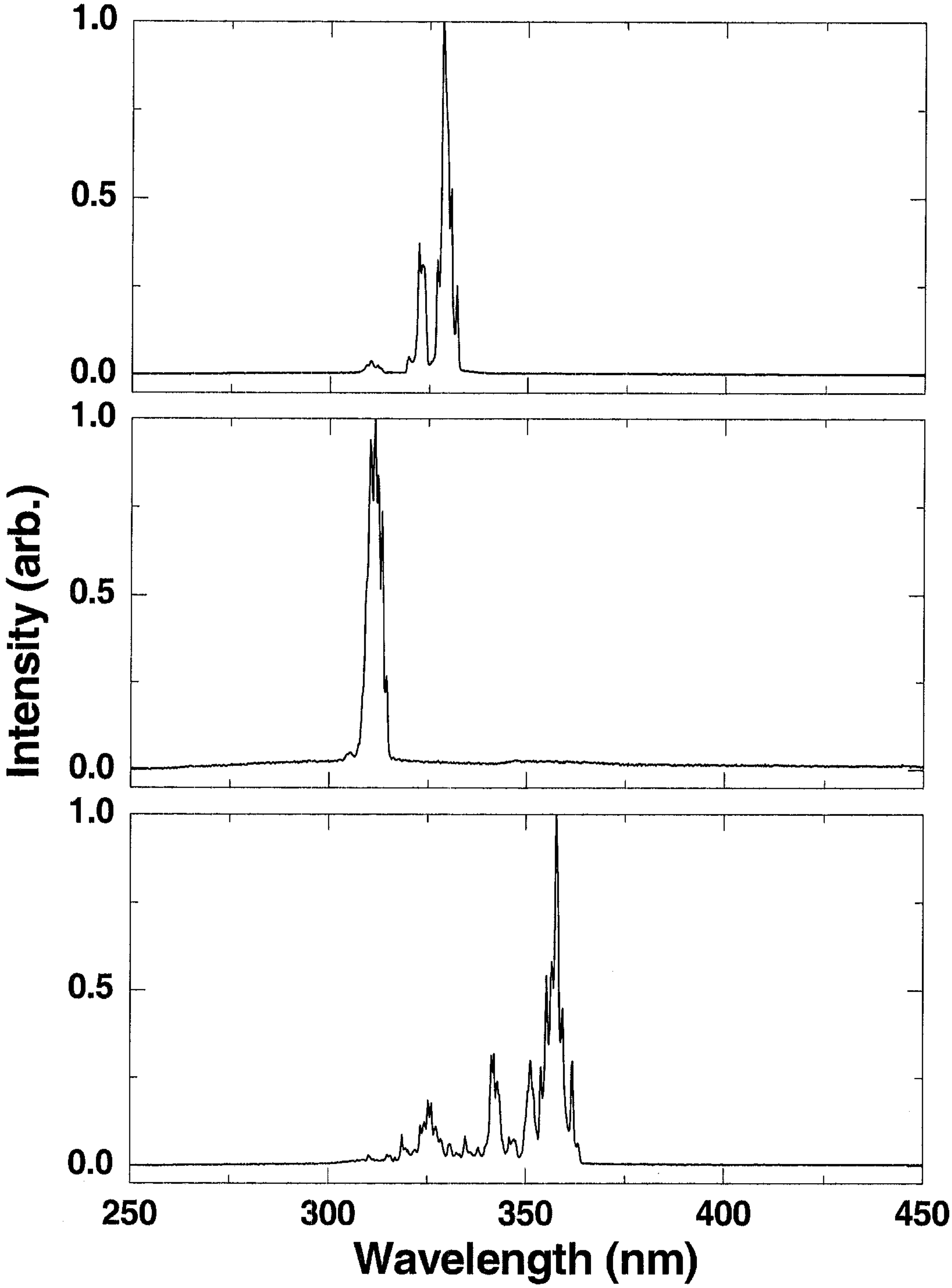

Fig. 1. Sample spectra of the light generated in the PCF around 330 nm in higher-order modes.

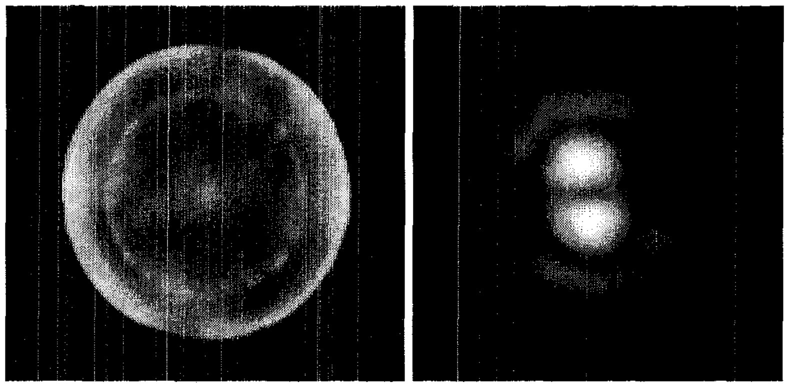

Fig. 2. Far-field spatial mode profiles of the generated UV light. Left: 310 nm, right: 400 nm. On the left image the multilobe ring comprises the mode of interest.

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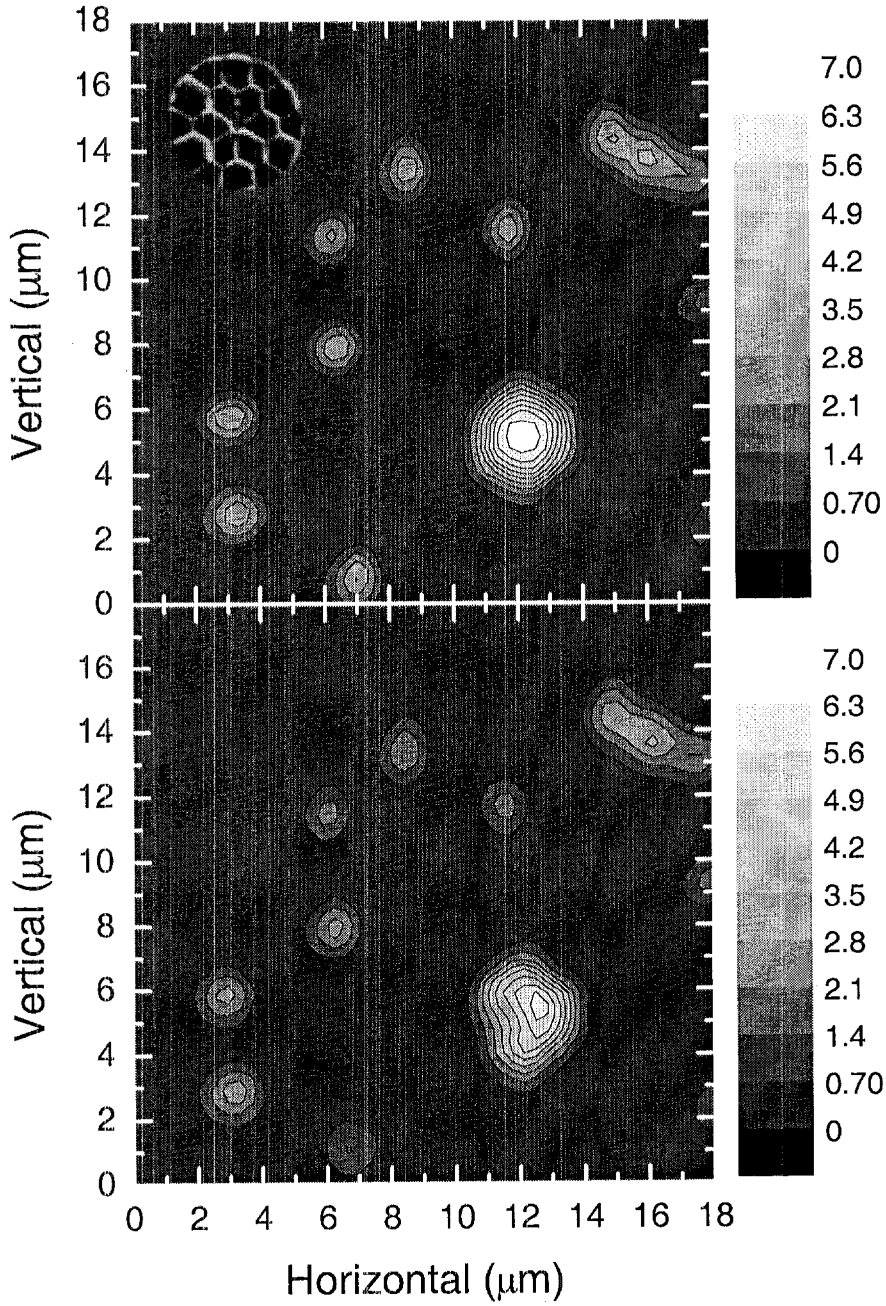

Fig. 3. Transverse guiding scans of the PCF before (top) and after (bottom) the controlled tip melting with the pump laser. Initially the hexagonal shape of the core is well seen, whereas after the melt the change to the core shape is observed. Small guiding regions correspond to the fiber support structure crossings.