Multiplex Coherent Anti-Stokes Raman Spectroscopy Setup with Femtosecond and Photonic Crystal Fibers

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Coherent Anti-Stokes Raman Scattering (CARS) is a spectroscopy method that can be very useful for analysis of chemical substances and biological tissues. The method is a special case of degenerated four wave mixing (DFWM) where two pump beams \( \omega_p \) and a stokes beam \( \omega_s \) are combined to generate another beam \( \omega_{CARS} \) with the following energy conservation rule \( \omega_{CARS} = 2\omega_p - \omega_s \). In CARS, the energy of the two input beams are selected in a way that \( \omega_p - \omega_s = \omega_{vib} \), where \( \omega_{vib} \) is the vibrational energy of a particular sample. In such case, the non-linear emission of CARS beam is increased several orders of magnitude. Therefore the CARS signal can be used to characterize different types of samples depending on its vibrational energies. However, in order to fully characterize the material is important to acess different vibrational energies, this is the so-called Multiplex CARS.

In the Multiplex CARS setup the pump (or stokes) beams is spectrally broad, hence it will probe a larger spectral range of vibrational energies. In this work we have setup two different multiplex CARS systems, one is made by using femtosecond lasers pulses as pump and stokes and the other by using a Photonic Crystal Fibers (PCF) as pump. For the first setup we have used 800 nm stokes from a Coherent Mira oscillator (120 fs) and the pump from optical parametric oscillator (from APE) with 120 fs. The two beams were temporally and spatially overlaped at a confocal microscope. The transmitted CARS signal was then directed to spectrometer (Andor) and detected by CCD (idus Andor). We have acquired spectrum of different samples: benzonitrile, acetonitrile, 1-Decanol, metanol and graphite; in different spectral regions (stokes near 630 nm and 750 nm). For these samples, the \( \chi^3 \) was characterized. For the second setup we have used PCF fiber to generate a spectrally broad pump beam that was temporally and spatially overlaped at the confocal microscope with the stokes beam at 800 nm (Coherent Mira). We will compare the these two experimental setups in order to do multiplex CARS in different samples with good efficiency and stability. We acknowledge financial support from CNPq, CAPES, FINEP and FAPEMIG.