AUTO AND CROSS CORRELATION MEASUREMENTS OF FEMTOSECOND LASER BEAMS IN SRS MICROSCOPE

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In this paper auto and cross correlation measurements of three femtosecond laser sources, a Ti:Sapphire (Ti:Sa) oscillotor, a femtosecond synchronized optical parametric oscillator (OPO) and a second Harmonic Generator (SHG), by two photon absorption are reported.

Keywords: Nonlinear optics, ultrafast optics, microscopy

1. Introduction

Stimulated Raman Scattering (SRS) microscopy proven high chemical selectivity of unlabeled living cells, and in addition, implement real time three-dimensional imaging with high spatial resolution and sensitivity. In SRS microscopy, two collinear laser beams, a high-power pump laser and a low power Stokes laser with different frequencies ($\omega_L > \omega_S$), are focused into a sample. When their difference matches the vibrational frequency of the molecular bonds of interest, energy is transferred from the pump beam to the probe beam, observable in an increase in probe signal intensity (Stimulated Raman gain, SRG) and a decrease of the pump signal intensity (Stimulated Raman Loss, SRL) [1-3].

In our previous paper [1], we reported the design and the implementation of a microscope based on femtosecond Stimulated Raman scattering (f-SRS), which is able to cover all the regions of Raman spectra: the fingerprint region (400 cm^{-1} – 1600 cm^{-1}), the silent region and the C-H region (greater than 2700 cm^{-1}). The experimental imaging setup is equipped with three femtosecond laser sources: a Ti:Sapphire (Ti:Sa), a femtosecond synchronized optical parametric oscillator (OPO) and a second Harmonic Generator (SHG). In order to cover all the regions of Raman spectra, they can be used in two different combinations. The first one, using Ti:Sa and OPO+SHG, we can cover in SRL modality the fingerprint region and the silent region. The second one, using Ti:Sa and OPO, we can cover the C-H region in SRG modality [4-6]. The system, not commercially available, is the result of the integration of a femtosecond stimulated Raman spectroscopy set up with C2 confocal Nikon microscope, which is made up by an inverted Nikon Ti-eclipse microscope and a scan head.

It is well known that pulses are routinely characterized by means of autocorrelator, where a time-delayed fraction(s) of a pulse interferes on an object having a non-linear optical response with the non-delayed remaining of the same pulse. Nonlinear process, in our case two photons absorption, can be recorded as a function of the time delay yielding the beam autocorrelation function. Auto correlation measurements are important because they allow to monitor the pulse duration and chirp of laser beam, which are a fundamental parameter to optimize the nonlinear interaction in microscopy.

Cross correlation measurements allow to determine the spectral resolution of our experimental set up, which is a fundamental to distinguish different biochemical molecules.

We investigate if our experimental set up can be suitable for imaging applications that probe for molecular specificity such as lipids and proteins in C-H region.

In this paper autocorrelation measurements of all three laser beams and cross correlation measurements between Ti:Sa and OPO and between Ti:Sa+SHG will reported and discussed.

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