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Femtosecond Laser Induced Spatiotemporal Control for Remote Sensing and Computation at Nanoscale

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Femtosecond laser pulses have been shaped in a programable manner for coherent control at molecular level and for several coherent optical processes that have resulted in applications to fast switching, data compression, ultrasensitive detection, computing, etc. Optical and quantum interaction and their detection remain at the forefront of all such efforts. Typically, however, it is not common for ultrashort time to be connected to ultra-small dimension. Use of femtosecond optical tweezers (FOTs) makes this connection possible. We have developed a novel on-the-fly calibration method of FOT that enables in situ control and contactless measure of absolute temperature and viscosity at nanoscale dimensions. Such measurements and control at the nanoscale have been challenging since the present techniques can only provide relative off-line measurements that are of low spatial resolution. Such spatiotemporal control with ultrashort pulses provides the possibility of manipulation at nanoscale that can yield several interesting results that include visualization of colloidal aggregation in real time, computational logical operation in localized zone that is then reset with the subsequent pulse train. We simultaneously apply the high temporal sensitivity of position autocorrelation and equipartition theorem to precisely measure and control in situ temperature and the corresponding microrheological property around the focal volume of the trap at high spatial resolution. The FOTs use a single-beam high repetition rate laser for optical trapping to result in finer temperature gradients in comparison to the continuous-wave laser tweezers. Thermal effects are often treated delirious and most spectroscopy efforts remain in removing them. We have, on the other hand, used highly repetitive femtosecond laser heating to develop time-resolved photothermal lens spectroscopy that provide molecule level sensitivity.

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2. Dipankar Mondal and Debabrata Goswami, “Controlling and Tracking of Colloidal Nanostructures through Two Photon Fluorescence”, Methods and Applications in Fluorescence, **4**(044004), 2016, pp. 1-7.