MAPPING OF MORPHOLOGICAL NANO-INTERSTICE USING LABEL-FREE MULTI-COLOUR SUPERRESOLVED FOUR WAVE MIXING (FWM)

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Superresolution techniques have substantial applications in biomedical analysis, intracellular activity monitoring, and all-optical investigation of nanostructures to name a few. In this study, we introduce a label-free method which is capable of sieving and mapping morphological nano-interstices down to 60 nm with high fidelity. In brief, a femtosecond pump beam delivered from a mode-locked Ti-Sapphire laser operated at λ=760nm with pulse duration of 80 fs was partly split into a 12-cm-long photonic crystal fiber (PCF) for generating a supercontinuum (SC) probe beam from λ=500 nm to 1200 nm with a chirp coefficient C = 43nm/ps. The SC probe beam was then gated by the pump at various time delays, and the combined beams were focused onto Au random films via a 100× objective lens. Multi-colour FWM signals were generated at different gated time slots and the back-reflected signal was collected, passing through a short pass filter, and directed to a spectrometer and EMCCD for spectral-spatial analysis.

Figure 1(a) shows the SEM image of the Au random film in this study. The relative time delay was scanned from δt = −1.333 ps to δt = + 1.333 ps in step of 133 fs, corresponding to FWM generation over λ=580-640 nm. The centroid of the diffraction-limited FWM image was superresolved using 2D Gaussian fitting. Fig 1 (b) shows the trajectory of the generated FWM centroid along with the accumulated density of the superresolved FWM intensity. It is clearly in evidence that the trajectory is quite repeatable with high accuracy (estimated to be ~20 nm) which reveals the morphological feature with high fidelity.

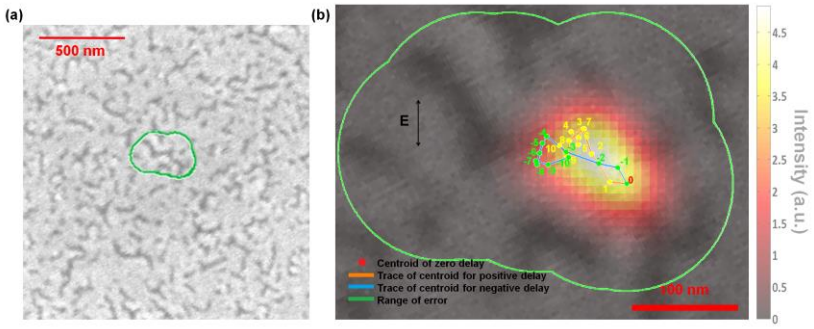

Figure 1 (a) The SEM image of the Au random film under study. (b) Trajectory of the superresolved FWM centroid which closely reveals the morphological nano-interstice.