“nano-FTIR spectroscopy of individual protein complexes”

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[Abstract]
We introduce the mapping of protein structure with 30 nm lateral resolution and sensitivity to individual protein complexes by infrared scattering-type scanning near-field optical microscopy (IR s-SNOM) and Fourier transform infrared nanospectroscopy (nano-FTIR). s-SNOM and nano-FTIR are based on recording the infrared light scattered by a metallized atomic force microscope tip probing the sample surface. We present and discuss local broadband spectra of individual viruses, ferritin complexes, purple membranes and insulin aggregates, which can be interpreted in terms of their alpha-helical and/or beta-sheet structure [1]. Applying nano-FTIR for studying insulin fibrils, we find clear evidence that 3-nm-thin amyloid-like fibrils contain a large amount of alpha-helical structure. Nano-FTIR spectra of one ferritin complex demonstrate extraordinary sensitivity to ultra-small amounts of material, about 1 attogram of protein, respectively 5000 C=O bonds. By further sharpening the tips and optimizing their antenna performance, we envision single protein spectroscopy in the future, paving the way to a new era in infrared bio-spectroscopy. We foresee manifold applications, such as studies of conformational changes in amyloid structures on the molecular level, the mapping of nanoscale protein modifications in biomedical tissue or the label-free mapping of membrane proteins.

[1] I. Amenabar, et al., Nature Commun. 4:2890 doi: 10.1038/ncomms3890 (2013)