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Nanophotonics of Chloroplasts for Bio-Inspired Solar Energy Materials PAUL L. GOURLEY, CHERYL R. GOURLEY, HighLight Research — In the search for new energy sources, lessons can be learned from chloroplast photonics. The nano-architecture of chloroplasts is remarkably well-adapted to mediate sunlight interactions for efficient energy conversion. We carried out experiments with chloroplasts isolated from spinach and leaf lettuce to elucidate the relationship between nano-architecture, biomolecular composition and photonic properties. We obtained high-resolution microscopic images of single chloroplasts to identify geometries of chloroplasts and interior grana. We performed micro-spectroscopy to identify strengths of absorption and fluorescence transitions and related them to broadband reflectance and transmittance spectra of whole leaf structures. Finally, the nonlinear optical properties were investigated with nanolaser spectroscopy by placing chloroplasts into micro-resonators and optically pumping. These spectra reveal chloroplast photonic modes and allow measurement of single chloroplast light scattering cross section, polarizability, and refractive index. The nanolaser spectra recorded at increasing pump powers enabled us to observe non-linear optics, photon dynamics, and stimulated emission from single chloroplasts. All of these experiments provide insight into plant photonics and inspiration of paradigms for synthetic biomaterials to harness sunlight in new ways.

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