

Title: Spectroscopic Study of Singlet Oxygen in Cells and Model Systems

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Abstract: Singlet oxygen ( $^1\text{O}_2$ ), the first excited state of molecular oxygen, plays many important roles in nature and technology. The work is aimed at development of novel methods for monitoring of  $^1\text{O}_2$  in cells and other biological samples. Two main approaches were employed: direct detection of the very weak near-infrared phosphorescence of  $^1\text{O}_2$ , and detection of Singlet Oxygen-Feedback Delayed Fluorescence (SOFDF), which is the emission from the photosensitizer induced by energy transfer from  $^1\text{O}_2$ . The first part of the thesis introduces the basic concepts of photophysics and photochemistry of  $^1\text{O}_2$ : its generation, deactivation, applications, and overview of detection methods. The second part presents the experimental results. Wide-field microspectroscopic detection of  $^1\text{O}_2$  phosphorescence enabled us to acquire  $^1\text{O}_2$ -based images and near-infrared spectra from single cells incubated with photosensitizers. However, the direct detection suffers from the inherently very low phosphorescence quantum yield. It is shown that SOFDF may overcome this problem and become a promising alternative tool for studies of  $^1\text{O}_2$  and excited states of photosensitizers. The work provides one of the very scarce systematic studies of SOFDF in biologically relevant samples, spanning from solutions of photosensitizers to time-resolved microscopic detection of SOFDF from individual living cells.

Keywords: singlet oxygen, phosphorescence, delayed fluorescence, time-resolved luminescence detection, photosensitizer