



Ultrabright Polymeric Nanoparticles for FRET Mediated Ratiometric Detection of Molecular Oxygen

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Optical sensing of molecular oxygen has attracted a great deal of scientific attention since the determination of oxygen concentration is essential in diverse areas ranging from life sciences to environmental sciences. It is particularly important for biomedical applications because tissue hypoxia has been found to be closely related to the clinical course of a variety of diseases, such as tumor growth, rheumatoid arthritis etc.¹ Fluorescent polymer nanoparticles (NPs), composed of conjugated polymers and organic dyes, have received great attention due to a number of unique properties, such as exceptional brightness, color tuning from visible to NIR region, potential biodegradability and low toxicity.² We previously reported the formulation of ultrabright dye-loaded fluorescent NPs based on biocompatible polymers such as PLGA, PMMA, etc loaded with cationic dyes and bulky hydrophobic counterions.³

With an objective to develop a FRET based ratiometric oxygen sensor, we made fluorescent polymeric nanoparticles containing a cyanine-based donor dye with a fluorinated counter ion and a porphyrin acceptor as the oxygen sensitive moiety. The preparation of the NPs was achieved by charge-controlled nanoprecipitation,^{3c} by varying the ratio between donor and acceptor concentrations in order to optimize their ratiometric emission response. The as formed nanoparticles were characterized through UV-Vis spectroscopy and DLS measurements. Steady state experiments suggest the efficient energy transfer from cyanine donor to porphyrin acceptor in the PMMA matrix. However, the phosphorescence emission of the porphyrin at 650 nm was suppressed by the dissolved oxygen in the solution, which recovered by the addition of increasing concentrations of sodium sulfite, a well-known oxygen scavenger. By varying the oxygen concentration in the mixture from 0 to 95%, we could be able to observe the enhancement of acceptor emission whereas the donor emission remained same, which facilitated the ratiometric detection. Time-resolved measurements also suggest the decrease in phosphorescent life time of the acceptor with increase in oxygen concentration. Further, we investigated the potential of the probe in single particle fluorescence imaging, after immobilizing NPs on a glass coverslip. Interestingly, we could observe bright emission from donor channel and no emission from acceptor channel in the presence of oxygen, and the enhancement in acceptor emission upon oxygen scavenging. The cellular uptake of NPs and ratiometric imaging of oxygen in cells are currently in progress. The small sizes, high brightness, and the ratiometric emission response make these NPs a good candidate for the quantitative detection and imaging of molecular oxygen in biological samples.

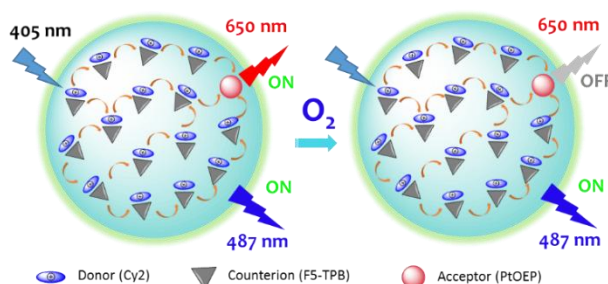


Figure 1. Schematic representation of dye-loaded NPs for ratiometric detection of molecular oxygen.

Bibliography

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