Bar-Ilan University
אוניברסיטת בר-אילן

Faculty of Exact Sciences | *הפקולטה למדעים מדויקים*
Department of Chemistry | המחלקה לכימיה

S P E C I A L S E M I N A R

Sunday 28/4/19, 12:00

Building 211, seminar room 112

SPEAKER:

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TOPIC:

Applications of Förster Resonance Energy Transfer for Production of Near-infrared Emitting Dye Micelles and the Manufacturing of Self-reporting Materials

The use of near-infrared (NIR) radiation in the field of non-invasive imaging for diagnostic applications is gaining increased scientific attention recently. A great advantage of the use of NIR light is its low absorption by body tissues which allows for greater penetration in living subjects [1]. Perhaps the most commonly used NIR dye is Indocyanine Green (ICG) which is FDA-approved and has been used extensively in the medical field. However, this dye is susceptible to photobleaching, thermal degradation and oxidation in acidic conditions [2]. Another tool commonly utilized in the field of bio-optical research is Förster resonance energy transfer (FRET), where an excited fluorophore donor transfers its excess energy to an adjacent acceptor and causes it to emit a photon [3]. It has also been observed that this process can decrease the donor's excited-state lifetime and fluorescence quantum yield, thus reducing its photobleaching rate [4]. In this seminar the concept of using FRET for the protection of NIR dyes against photodecomposition will be introduced. Several systems of FRET micelles with ICG and the dye IR-1061 will be discussed. For example, DSPE-PEG micelles endow ICG with increased stability against chemical, thermal and photo-decomposition. Moreover, the dye's ability to generate heat through the photothermal effect is greatly enhanced compared to its free form. At the same time, this system generates less reactive and toxic singlet oxygen. Another micellar system that will be presented is PCL-PEG, which is especially useful for *in-vivo* imaging. These PCL-PEG FRET micelles display superior brightness and contrast compared to micelles containing each dye alone. *In-vitro* studies demonstrate how the particles can also cause death of cancer cells by local heating, making them promising candidates for cancer treatment.

Another use of FRET for the production of self-reporting materials will be presented. By incorporating donor and acceptor dyes in poly(dimethylsiloxane) (PDMS) and monitoring the change in emission spectra, it is possible to detect the strain applied on the elastomer [5]. As strips containing a FRET couple are extended, the distance between donor and acceptor molecules increases, resulting in a decline in energy transfer efficiency. First, the successful doping of the elastomer with the dyes fluorescein and rhodamine B is demonstrated by using different optical techniques. The detection of strain in strips upon stretching is shown by fluorescent spectrometry. Next, strain in samples is visualized using a simple digital camera and basic image-processing methods. Finally, a gradual flexibility PDMS sample was manufactured and the nonuniform distribution of strain in it is charted.

References

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[2] A. P. Gorka, R. R. Nani, and M. J. Schnermann, “Cyanine polyene reactivity: scope and biomedical applications,” *Org. Biomol. Chem.*, 2015.

[3] T. Förster, “Transfer mechanisms of electronic excitation,” *Discuss. Faraday Soc.*, vol. 27, no. 10, p. 7, 1959.

[4] G. W. Gordon, G. Berry, X. H. Liang, B. Levine, and B. Herman, “Quantitative fluorescence resonance energy transfer measurements using fluorescence microscopy.,” *Biophys. J.*, vol. 74, no. 5, pp. 2702–13, May 1998.

[5] G. Yeroslavsky, R. Inoue, M. Kamimura, Y. Kogo, and K. Soga, “Visualization of Strain in Elastic Silicone Polymers Using Fluorescence Energy Transfer,” *J. Photopolym. Sci. Technol.*, 2018.