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Quantum-Dot-Based biosensor of matrix metalloproteinase activity

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Matrix metalloproteinases (MMPs) are a large family of highly homologous Zn++ endopeptidases that can bind to non-terminal amino acids in peptides with specific amino acid sequences. Their abnormal activity is associated with a large number of pathological conditions, such as cancer, metastasis, arthritis, nephritis, liver fibrosis, and central nervous system disorders, including Alzheimer's disease, multiple sclerosis, Lou Gehrig's disease, and neuropathic pain. MMP enzymes catalyze hydrolysis at specific non-terminal bonds between amino acids in peptide chains, essentially cleaving the peptide substrate in two. The ubiquitous presence of MMPs in a large number of pathological conditions offers a very attractive new way of early detection of these conditions through biosensing of MMP activity. In this paper, we describe a novel biosensor of MMP activity based on colloidal quantum dots (QDs). Cd-free hydrophobic Mn-doped ZnSe/ZnS core/shell QDs were synthesized under air-free conditions utilizing multi-shell layer growth. Our choice of Mn-doped ZnSe/ZnS QDs is driven by their bright emission at room temperature and above, and by the same shell composition as in the standard CdSe/ZnS QDs, which readily permits adoption of previously developed conjugation techniques. The QDs were hydrophilicised using mercaptoacetic acid, and bioconjugated to polypeptides exploiting the cysteine-thiol/metal affinity. Preliminary studies reveal an increase in photoluminescence intensity and quantum efficiency between QD/peptides containing the peptide enzyme substrate in the pre-cleaved and cleaved form, respectively. Consequently, proportionality of the QD emission intensity to the length of the conjugated peptides can be used to quantify, in real time, the activity of MMPs.

Biography

Marek Osiński is a Gardner-Zemke Professor of Electrical and Computer Engineering, Physics and Astronomy, and Computer Science at the University of New Mexico. He received his M.Sc. in Physics degree from the University of Warsaw, Poland, in 1971, and his Ph.D. in Physical Sciences degree from the Institute of Physics, Polish Academy of Sciences in Warsaw, Poland, in 1979. He is a Fellow of SPIE (2002) and of the Optical Society of America (2003), and is currently serving an Associate Editor of IEEE Photonics Journal. He has published more than 480 papers in professional journals and conference proceedings.

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