

# ***Development and Characterization of Fluorescent Microparticle Oxygen Sensors: Miniaturized Probes for Cellular Microenvironment in 3D Cultures***

***Miguel A. Acosta, Yordan Kostov, Jennie B. Leach***

*University of Maryland – Baltimore County, Department of Chemical and Biochemical Engineering*

Understanding the mechanisms underlying cell response to cues from their biomaterial microenvironment will ultimately lead to improved methods to control cell behavior in tissue replacement therapies. Whereas many methods have been established for characterizing cellular behavior and physical properties of biomaterial scaffolds, few methods exist for quantitatively mapping the fluctuations of soluble cues that impact cellular function. Our current work focuses on developing novel technologies for sensing spatial and temporal changes in oxygen content during 3D culture. Oxygen is required for the aerobic metabolism of carbon compounds in cells and as such is a critical parameter (along with pH, temperature, and nutrient supply) that impacts cell viability. Furthermore, oxygen tension itself is a cue that directly impacts cell response (*e.g.*, migration). Measurements of oxygen concentration in laboratory scale tissue culture systems prove difficult because traditional oxygen-sensing approaches are not amenable to miniaturization. Moreover, oxygen-sensing electrodes also consume oxygen during operation. We present the development of a microparticle oxygen sensor based on fluorescence quenching of the oxygen-sensitive fluorophore tris (4,7-diphenyl-1,10-phenanthroline) ruthenium (II) dichloride, or  $\text{Ru}(\text{Ph}_2\text{phen}_3)\text{Cl}_2$ . The sensor is made by simple two-step process – electrostatic immobilization of the oxygen-sensitive fluorophore to silica gel followed by encapsulation of the silica gel with polydimethylsiloxane (PDMS). This process yields fluorescent microparticles that can be suspended on any substrate or scaffold used in any laboratory-scale tissue culture system. By monitoring the fluorescence quenching of the oxygen-sensitive fluorophore, measurements of both temporal and spatial changes on oxygen concentration can be carried out in a non-invasive manner without consuming the oxygen available to the cells during culture.

***Miguel A. Acosta***  
***Department of Chemical and Biochemical Engineering***  
***University of Maryland - Baltimore County***  
***1000 Hilltop Circle, ECS 332-A***  
***Baltimore, MD 21250***  
***410.455-3435***  
***[acosta1@umbc.edu](mailto:acosta1@umbc.edu)***