Melanins - Bio-electronic Materials

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The melanins are a class of functional bio-macromolecules found throughout nature [1]. In humans, they serve as our pigment and primary photo-protective system, and are also found in the *substantia nigra* of the brain where their role is not completely understood. Elsewhere in the biosphere melanins act as structuring agents and adhesive coatings. The melanins also possess a rather intriguing set of physico-chemical properties including strong, broad-band monotonic absorbance, electrical and photo-conductivity and efficient non-radiative dissipation of absorbed photon energy. It is this collection of properties that has led to recent speculation that these systems may be the basis for a new class of bio-inspired optoelectronic materials for applications such as chemi-sensing, ultra-capacitors and photon detectors [2].

Before this potential can be realized a number of key issues need to be addressed: i) correct and predictive mesoscopic models for key photochemical and photophysical properties need to be derived, ii) the physical chemistry of adsorbate-melanin interactions needs to be understood, and iii) we need to molecularly engineer these systems so as to produce device quality thin films. In my talk I will discuss recent progress towards fully addressing these issues. The transport and photo-physics in particular is complex since the melanin system in the solid state appears to show properties highly dependent upon hydration state. Such properties can be harnessed to create bio-electronic gas sensors. Additionally, the photophysics and photochemistry is complicated by the extreme disorder in the system and the strong non-radiative coupling that quenches virtually all fluorescence. We also show that the basic molecular properties of melanins can be engineered so as to produce solution processible thin films of similar quality to synthetic semiconducting polymers [2].

[1] Meredith, P. & Sarna, T. *Pigm. Cell Res.* **19**, 572-594 (2006).
[2] Bothma, J. P., et al. *Adv. Mater.* **20**, 3539-3542 (2008).