**Nanoscale Design of Carbons for Electronic Applications**

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Carbon as a material can have many faces and phases! It can bond to itself and other elements, creating a plethora of material types. The structure, topology, chemical, mechanical and opto-electronic properties, all are dependent on the bonding hybridisation between carbon atoms. This allows for a versatile nano-electronic material that can be designed for applications. The continuous demand for higher performance in electronic devices puts pressure on sustainable development and has driven industry to carefully examine optimum design methodology. Design of materials at the nano-scale allows one to optimise performance and increase efficiency. When the wavelength of interest in the case of solar cells and photonic devices are also in the nano-scale, fundamental improvements can be made to the devices in terms of performance and power usage.

In this study we examine the design of four separate photonic technologies, with a view to optimise its performance beyond traditional limits using hybrid nano-carbon organic-inorganic structures. Firstly, we examine the design of 4th Gen hybrid solar cells; using inorganic CNT OPV and perovskite PPV where nanoscale design is critical for maximising absorption and change transfer. Then we examine the use of hybrid structures for high performance X-ray detectors that can be used to overcome attenuation limits associated with photon scattering via the photoelectric effect to give flexible, broadband high sensitivity detectors. Then, the nanoscale design aspect is used to produce features that can mimic moth eye structures to produce some of the most absorbing materials ever manufactured using thin decoupled layers of graphene. Finally, the use of carbon nanotubes to make devices including the world’s darkest buildings – nanoscale design for macroscopic impact. These have significant potential for opto-electronic devices.

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