Carbons dots as sensors, carriers and catalysts.

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Abstract
The paper will summarise the last decade of my team's research on carbon dots. Prior to 2014 the team worked on semi-conductor dots as sensors for water contaminants and markers in physical systems [1] but in 2014 realised that the perceived toxicity of such dots would hinder their acceptance into environmental and biomedical fields. As such we moved to carbon dots demonstrating in a seminal paper [2] in 2015 how by controlling precursors and the formation process carbon dotes could be formed with a controlled fluorescent across the visible light range from blue to deep red. Further it was demonstrated that the fluorescence was largely controlled by the surface groups on the dot particularly the oxygen and nitrogen containing groups. Worked advanced to demonstrated that the surface functional groups could be manipulated to allow the dots to act as sensors including for Copper ion and L-cysteine [3]. If the functional groups were correctly selected and formed, then they could be tuned to bind to specific analytes in solution. This binding would disrupt the passivity of surface and decrease the florescent. The degree of the fluorescent decrease was found to be proportional to the concentration of the analyte in solution. Additional work demonstrated that the carbon dots in appropriately doped and with the correct surface groups could act as catalyst. In one application [4] it was demonstrated that given a small concentration of hydrogen peroxide the dots could catalyse the formation of oxygen and hydroxyl radicals that could promote the breakdown on water contaminants such as dies including methylene blue. Iron doping was found to be particularly effective in enhancing this catalytic activity which may have been related to the development of a strong negative charge of the dot that attracted the contaminant. The most recent work has been the use of dots carriers of RNA-i into the leaves of plants . the dot/RNA-i complex can be sprayed onto the plant leaves where it penetrates the cells of the plane leaves and may act to reduce insect or microbial attack. The work has applications across the environmental (water sensors) , bio-engineering (numerous) and plant/food industries (RNA-I delivery) . Two additional bio -applications worthy of note are the impregnation of bandages with dots to both signal the onset of infections and to act as anti-microbial agents[5] and the use of dots to make fibres used in the human body as sinters and meshes more visible by X-ray post operation when they need to be removed. The science behind all these applications as well as the engineering will be outlined

References

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