Carbon dots as metal free catalyst for the removal of industrial hazardous dyes

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The discharge of dyes, specifically synthetic dyes into the aqueous system from industrial sources represents a serious environmental problem due to their toxicity to aquatic life and mutagenicity to humans. Some synthetic dyes are extremely resistant to biodegradation and therefore several methods have been developed to assist in their removal [1]. Recently, the use of nanomaterials for the remediation of pollutants has been successfully applied, showing promising results, especially for the removal of dyes from water. As an emerging subset of nanomaterials, carbon dots are nanoparticles in the size range of below 10 nm that present unique characteristics such as stable fluorescence, low toxicity and high aqueous solubility, and are also known to participate in rapid electron transfer properties in catalysis [2]. In this study, carbon dots were synthesised using green precursors (Fig. 1) and tested as metal free catalysts in the "Fenton-like" reaction for the degradation of three synthetic dyes under room temperature (20 ±2°C) and at neutral pH (7.5). Results showed that nanoparticles with 10 nm average diameter were formed and they manifested a negative surface charge across a range of pH conditions. In the presence of H_2O_2, the carbon dots were able to act as catalysts in a "Fenton-like" process removing 100% of dyes (Fig 2) after only 30 minutes; in the absence of carbon dots the removal was of only 15%. The results suggest that the carbon dots are involved in the transference of electrons, participating in the decomposition of H_2O_2, resulting in the generation of free radicals in solution which are responsible for the degradation of dyes.

References

[1] Javaid, R. and U.Y. Qazi, *Catalytic Oxidation Process for the Degradation of Synthetic Dyes: An Overview.* Int J Environ Res Public Health, 2019. **16**(11).
[2] Liu, M.L., et al., *Carbon dots: synthesis, formation mechanism, fluorescence origin and sensing applications.* Green Chemistry, 2019. **21**(3): p. 449-471.

Figures

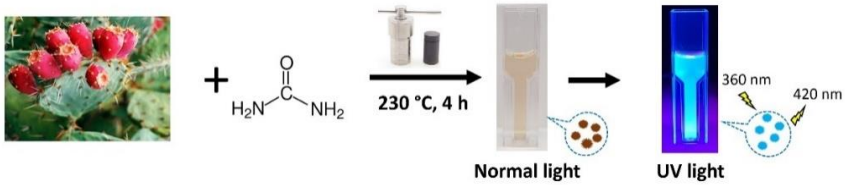

Figure 1. One-pot hydrothermal synthesis of the prickly pear carbon dots.

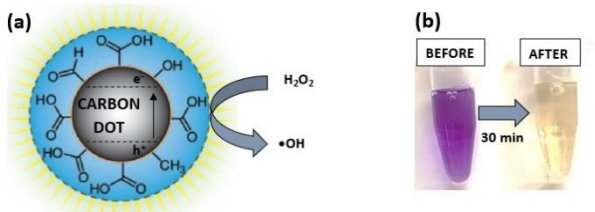

Figure 2. (a) Schematic illustration of the catalytic degradation of dyes (b) digital images of dyes before and after degradation.