Synthesis of multi-coloured photoluminescent carbon dots from waste coffee grounds and application as bio-nanocomposite based markers for anti-counterfeiting and secured object traceability

Aïssatou Coumba Sow [a,b], Etienne Palleau[a], Isabelle Fabre - Francke [b]
[a] LPCNO, Université de Toulouse, CNRS, INSA, UPS, 135 avenue de Rangueil, 31077 Toulouse, France
[b] AEROPROTEC, 6 Rue Vincent Auriol, 64000, Pau, France

Corresponding author email: epalleau@insa-toulouse.fr

Counterfeiting of products, top source of criminal income worldwide, is a long-simmering global issue. It threatens nearly every product category across all industrial sectors (e.g., electronics, apparel, food, toys, pharmaceuticals, guns, etc.) and poses a major risk to consumers, producers, and governments [1]. Thus, the capacity to guarantee secure traceability, confirming both origin and conformance, is a crucial need that necessitates ongoing vigilance in addition to continuously updated or enhanced technologies to prevent fraud, identify, and track fakes [2].

Our work aims to develop fully bio-sourced photoluminescent nanoparticles-based secured micro-tags that can be printed directly onto the surface of any object or product of interest. A specific wavelength light is used to excite embedded photoluminescent nanoparticles and thus benefit from their optical response to gain color contrast required to read and translate related encoded information using a smartphone. Rather than employing toxic cadmium-based quantum dots [3], we propose a sustainable approach using carbon dots from coffee grounds. We combine them with a UV curable soy-based resist to create UV patternable bio-nanocomposites. These nanocomposites are applied as drops to a surface, where they are then further patterned with UV micro-imprinting to create different desired geometries, such as QR codes, bleams, logos, etc. We will present the easy to implement synthesis protocol of the carbon dots along with their characterization. Additionally, we will show the robustness of the obtained micro-tags and how they can be applied in different frameworks, in particular in the aerospace industry.

[1] U.S. gov’t accountability off., gao-18-216, intellectual property: agencies can improve efforts to address risks posed by changing counterfeit market, p.10, 2018, Available from https://www.gao.gov/assets/690/689713.pdf (accessed march 20, 2024).
[2] United Nations Office on Drugs and Crime (UNODC), p.2, 2013. Available from https://www.unodc.org/documents/counterfeit/FocusSheet/Counterfeit_focussheet_EN_HIRES.pdf (accessed march 20, 2024).
[3] S.J. Park and H.K. Yang, Current Applied Physics 36 (2022) 9–15