Luminescent mechanoresponsive nanocomposite

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The direct translation of a mechanical force into an easily readable luminescence signal opens up new perspectives in the field of materials and mechanical stress detection. To date, these functional materials are mainly based on the integration of emissive organic mechanophores. However, these compounds are limited by their photobleaching problems, lack of sensitivity and synthesis costs. The aim of this internship is to explore a new detection concept by developing low cost, mechanoreactive hybrid luminescent copolymers incorporating two complementary emitters: 3-oxindole derivatives and octahedral molybdenum clusters (Mo6) .

Mo6 are red phosphorescent with high quantum yields, have excellent photostability and are very sensitive to O2. Derivatives of 3-oxindoles are blue-green luminescent and can be easily functionalised to copolymerise and interact with Mo6. This project brings together 2 fundamental concepts in a single material: i) the quenching of phosphorescence by O2, which destroys the O2 molecules by producing singlet oxygen, ii) the variation of oxygen permeability under mechanical stress of semi-crystalline polymers. As described in Figure 1, such changes modify the emission colour of the nanocomposite containing the two emitters, thus allowing the direct visualisation of a mechanical stress under UV-2A irradiation.

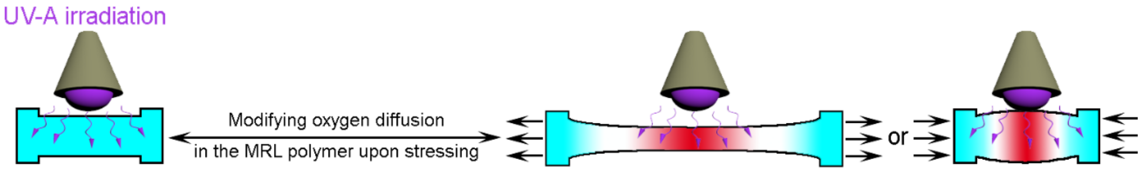

Figure 1. Mechanical stress detection principle under UV-A irradiation.

This pluridisciplinary project is organised in several phases combining molecular and macromolecular synthesis, pure and in-operando photophysical studies (coupled with mechanical sensing). The person recruited will benefit from a threefold training in synthesis and characterisation of hybrid polymers in the OMC (M. Achard) and CSM (M. Amela-Cortes, Y. Molard) teams, in photophysical measurements (Caphter UAR ScanMAT platform) and in characterisation of mechanical behaviour with and without UV-2A irradiation (IPR, QI2M team).

This PhD project is part of the ANR "Everyone" research project (2024-2028). The successful candidate will have a profile as a molecular chemist with recognised skills in organic synthesis and ideally skills in optical spectroscopy (absorption, emission). Due to the interdisciplinary nature of the project, the ideal candidate will show a high degree of initiative and willingness to advance the topic in its entirety: from organic synthesis to mechanical testing. He/she must be able to work in a team in an international environment (fluency in English is mandatory).

Related publications:

Khlifi, S.; Fournier Le Ray, N.; Paofai, S.; Amela-Cortes, M.; Akdas-Kilic, H.; Taupier, G.; Derien, S.; Cordier, S.; Achard, M.; Molard, Y., Self-erasable inkless imprinting using a dual emitting hybrid organic-inorganic material. Mater. Today 2020, 35, 34-41.

Robin, M.; Dumait, N.; Amela-Cortes, M.; Roiland, C.; Harnois, M.; Jacques, E.; Folliot, H.; Molard, Y., Direct Integration of Red-NIR Emissive Ceramic-like AnM6Xi8Xa6 Metal Cluster Salts in Organic Copolymers Using Supramolecular Interactions. Chem. Eur. J. 2018, 24 (19), 4825-4829.

Amela-Cortes, M.; Paofai, S.; Cordier, S.; Folliot, H.; Molard, Y., Tuned Red NIR phosphorescence of polyurethane hybrid composites embedding metallic nanoclusters for oxygen sensing. Chem. Commun. **2015**, 51, 8177-8180.

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