Project No. 02416

Report form of Joint Research Project at ZAIKEN (FY2024)

Title of Project	Photoactive nanocomposites for the inactivation of multi drug resistant pathogens		
Priority Area	I-B(Prolongation of service life & Structures), II-A(4R & Processes), II-B(4R & Structures)		
	New proposal		
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Institution	University of Orléans (France)	**title**	Dr. (Associate Professor)

Aim of the research project

Microbial pathogens exhibiting multidrug-resistance as well as the presence of persistent organic contaminants in water (nanoplastics or perfluorinated compounds...) constitute serious threats to humanity and ecosystems. The recent emergence of multi-resistant bacteria (ie super bacteria) rises the problematics of the massive uses of antibiotics therapy and their efficiency (even 3rd generation drugs) pushing the development of alternative strategies for the inactivation of the microbial pathogens. In addition to this serious hazard, water compartments are massively contaminated by anthropic pollutants: nanoplastics, perfluorinated compounds, pharmaceuticals, trace elements…
In regard to these current serious environmental and health issues, this project aims at developing nanocomposite systems based on graphene oxides (GO) and photosensitizer transition metal clusters as versatile and alternative (4R) systems for the inactivation of microorganisms (bacteria, fungus) as well as for the degradation of organic contaminants in water since these systems can show relevant photocatalytic properties.

Contents and results of the research

1. Graphite oxide was synthesized based on the modified Hummer's method and was also thermally reduced
2. Graphene oxide (GO) was properly dispersed in aqueous media
3. Graphene oxide (GO) was freeze dried and properly dispersed in dimethyl sulfoxide (DMSO) and tetrahydrofuran (THF) organic solvents forming stable colloidal dispersions
4. Two Mo based clusters were synthesized and used in this research: bidimensional Mo_6I_{12} clusters and spherical Mo_6 clusters with phosphonate and azido apical ligands
5. Photosensitizing Mo_6 clusters were characterized by XRD, FTIR techniques (XPS and Raman characterizations at several exciting wavelengths were performed in France)
6. Due to their ability to be hydrolyzed, the Mo clusters were dispersed in DMSO and THF organic solvents prior their association to GO
7. Due to their opposite electrical charges as well as similar hydrophobic moieties, both GO and Mo_6 clusters were easily associated in a colloidal state in DMSO and THF solvents
8. The resulting hybrid materials were characterized by a set of complementary techniques for a complete understanding of their structural organization and morphologies
9. The photophysical properties of the hybrid material will be characterized later
10. Their antimicrobial properties will be later investigated, as well as their photocatalytic properties for the degradation of persistent micropollutants (nanoplastics or other emerging contaminants: pharmaceuticals)

In addition to the proposal, my stay at Zaiken allows me to discuss with the research group of Prof. Sugahara about different projects related to the liquid crystalline assemblies formed by Janus nanosheets as well as their use as template for functional colloids for the development of hybrid materials. It allows me also to discuss about previous results with Prof. Sugahara for the writing of a paper that may be submitted this year.

Outputs of the project (publications, presentations, patents)

A paper related to this proposal should be submitted within this year.