Période de stage : Janvier-Juillet 2022 Laboratoire **L2CM**-UMR 7053-FST-UL

Title: **Synthesis of Mesoporous MoS_2 nanozymes for antibacterial photothermic applications**

Context: Bacterial resistance has been an escalating global threat to human over the past few decades. Due to the lack of effective antibiotics, drug-resistant bacteria-associated infectious diseases have caused over 700 000 deaths annually in the world.[1] More seriously, the development of novel antibiotics has stagnated due to the ever-increasing cost.[2] Therefore, alternative strategy to effectively combat drug resistant bacteria is highly required. In recent years, catalytic treatment based on nanozymes has been considered as a promising therapeutic strategy for antibacterial applications.[3] Nanozymes, are nanomaterials with enzyme-like activities with high structural stability, adjustable catalytic activity, functional diversity, recyclability, and feasibility in large-scale preparation. It has become a hot spot in the field of artificial enzymes in recent years and are expected to become potential surrogates and competitors for natural enzymes in practical applications.[4]

Typically, nanozymes can inactivate bacteria by catalysing the production of reactive oxygen species (ROS). For example, oxidase-mimic nanozymes can produce H_2O_2 by catalysing the reaction of substrates with O_2; peroxidase-like nanozymes can covert H_2O_2 to hydroxyl radicals (•OH). Compared with antibiotics, the bactericidal way of ROS can avoid the occurrence of bacterial resistance, and thus developing antibacterial strategy based on ROS is very promising.[5] Currently, many nanozymes with enzyme-like and antibacterial properties, including metal, carbon, and metal oxide/chalcogenide nanomaterials, have been demonstrated for killing various bacteria and even drug resistant bacteria.[3]. Many previous reports proved that photocatalysts exhibit promising potential as antibacterial agents based on their photothermal effects and light-induced ROS production. However, the development of light-activated antibacterial nanomaterials with easy preparation, low cost, and high photoactivity is still an urgent task to combat bacterial infections.[5] To overcome this shortcoming, the combination of the nanozymes-based catalytic treatment and photothermal therapy (PTT) is a promising solution. [6]

Especially, bioinspired Mo-based nanomaterials show great potential for the construction of novel nanozyme catalysts due to their variable oxidation states. Construction of vast Mo-based nanozymes has attracted enormous interest in biomedicine. [7] Hence, we propose to synthesis mesoporous MoS_2 nanoparticles and study the antibacterial properties with and without NIR irradiation

Principal mission:

- Synthesis and characterization of mesoporous MoS2 nanoparticles.
- Study their photothermal catalytic activity.
- The analysis of the photo-physical properties (fluorescence, $^1O_2$, photoacoustic)
- Study their stability in biological media.

Desired profile: The candidate should have a strong knowledge in **materials synthesis** and **nanoparticles characterization**. For international candidates, thorough knowledge of English and French would be appreciated.

Application: Applications should be sent to Almudena Marti (almudena.marti-morant@univ-lorraine.fr) and must include a CV and the transcript of records of BSc and MSc levels.

References

(1) Chen, Z.; Wang, Z.; Ren, J.; Qu, X. Enzyme Mimicry for Combating Bacteria and Biofilms. *Accounts of Chemical Research* **2018**, *51* (3). https://doi.org/10.1021/acs.accounts.8b00011.

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