جامعة عبد المالك السعدي
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Université Abdelmalek Essaadi

Pole for Doctoral Studies
Center for Doctoral Studies Sciences, Technologies, and Medical Sciences

ANNOUNCEMENT OF DOCTORAL THESIS DEFENSE

M. BAKHADA Mohamed

Will present their research work with the aim of earning a Doctorate

Doctoral program: Biology, Geology, and Chemistry (BCG)
Discipline: Chemistry
Specialty: Materials, Organometallic Chemistry, Catalysis, and Photocatalysis

On 16/05/2026 at 10H 30 at the Meetings Room of the Department of Chemistry, Faculty of Sciences of Tetouan, UAE
Under the Theme

- **Development of new catalytic systems involving:**
  - **Natural phosphates: application to the oxidation of aldehydic compounds and alcohols using dioxygen.**
  - **Heteropolyacids "H3+n[PMo12-nVnO40].aq": application to the oxidation of alcohols using dioxygen and to the polymerisation of lactams.**
- **Synthesis and characterisation of new ligands and new ruthenium(II)- or iridium(III)-based complexes: photocatalytic transformation of indoles and indolines into anthranilate esters.**

Front of the jury composed of :

First Name & Last Name	Establishment	Designation
Pr. EL AMRANI Mohamed El Amin	FS of Tetouan, UAE	President
Pr. KHADDOR Mohamed	FST of Tangier, UAE	Reviewer
Pr. LACHERAI Abdellah	FS of Agadir, UIZ	Reviewer
Pr. M'HAMDI ALAOUI Fatima Ezzahrae	FS of Tetouan, UAE	Reviewer
Pr. NOUINOU Mohamed	FS of Tetouan, UAE	Examiner
Pr. SOUSSI EL BEGRANI Mohamed	FS of Tetouan, UAE	Examiner
Pr. DAKKACH Mohamed	ISPITS of Tetouan, MSPS	Co-supervisor
Pr. ATLAMSANI Ahmed	FS of Tetouan, UAE	Supervisor

Host Research Structure: Laboratory of Materials Engineering and Sustainable Energy (IMED-Lab)

Abstract

The catalytic oxidation of aldehydes and alcohols using molecular oxygen as a green oxidant was investigated using natural phosphate and fluorapatite as heterogeneous catalysts. Near-quantitative conversions and high selectivities were obtained for aldehyde oxidation under mild conditions with the NP/O_2/AcOH-H_2O system, which retains its activity for at least four consecutive cycles without loss of efficiency. The oxidation of primary and secondary alcohols to the corresponding aldehydes and ketones proceeded efficiently, owing to a strong synergistic interaction between the fluorapatite structure and the incorporated metal oxides. Density functional theory calculations provided detailed insights into reaction pathways, intermediate species, and transition states, enabling the high catalytic activity, stability, and resistance to deactivation to be rationalised.

Keggin-type heteropolyacids "$H_{3+n}[PMo_{12-n}V_nO_{40}]$,*aq*" (HPA-*n*) were studied as homogeneous catalysts for oxidation reactions using molecular oxygen. The catalytic system HPA-2/O_2/AcOH-H_2O showed remarkable efficiency for the oxidation of primary and secondary alcohols, leading to carboxylic acids and ketones with high conversions and selectivities. The catalyst retains its activity over several cycles. The reactivity of ε-caprolactam under catalytic system HPA-2/O_2 was found to be strongly dependent on the reaction medium. In protic polar solvents, oxidative ring opening selectively affords 6-aminocaproic acid, whereas in tetrahydrofuran the same catalytic system promotes acid-catalysed ring-opening polymerisation, leading predominantly to nylon-6. Structural and thermal characterisations by NMR, and DSC confirmed the formation of semi-crystalline nylon-6.

In addition, four imidazo[4,5-f][1,10]phenanthroline ligands functionalised with alkynyl groups were synthesised and characterised, then coordinated to ruthenium(II) or iridium(III) centres to afford six Ru(II) and Ir(III) complexes.

Green and efficient photocatalytic methodology was developed for the transformation of indoles and indolines into anthranilate esters under visible light and molecular oxygen. The integration of oxidation, functionalisation, and one-pot sequential processes illustrates the power of photocatalysis to streamline synthetic routes while maintaining sustainability and scalability.

Keywords: Green catalytic oxidation; molecular oxygen; natural phosphate; fluorapatite; heteropolyacids; oxidation of alcohols; oxidation of aldehydes; ε-caprolactam polymerisation; nylon-6; density functional theory; photocatalysis; ruthenium(II) complexes; iridium(III) complexes; indoles; indolines; anthranilate esters; visible light; catalysis.