JED397: Physics and Chemistry of Materials Doctoral School Days

Degradation of organic pollutants by a new eco-compatible process

Molecular approach using FTIR-ATR at the surface-water interface

Ana Carolina SCHUH FRANTZ[1,2]

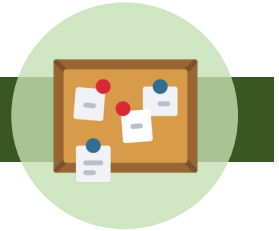
Alberto MEZZETTI[1], Guillaume MORIN[2], Xavier CARRIER[1]

[1]Laboratoire de Réactivité de Surface, LRS

[2]Institut de Minéralogie, de Physique des Matériaux et de Cosmochimie, IMPMC

2 & 3 November 2023

Our motivation



Increase of **organic pollutants** in nature

- Insecticides, herbicides
- Plasticizers, surfactants, chlorinate solvents
- **Antibiotics**, analgesics, hormones

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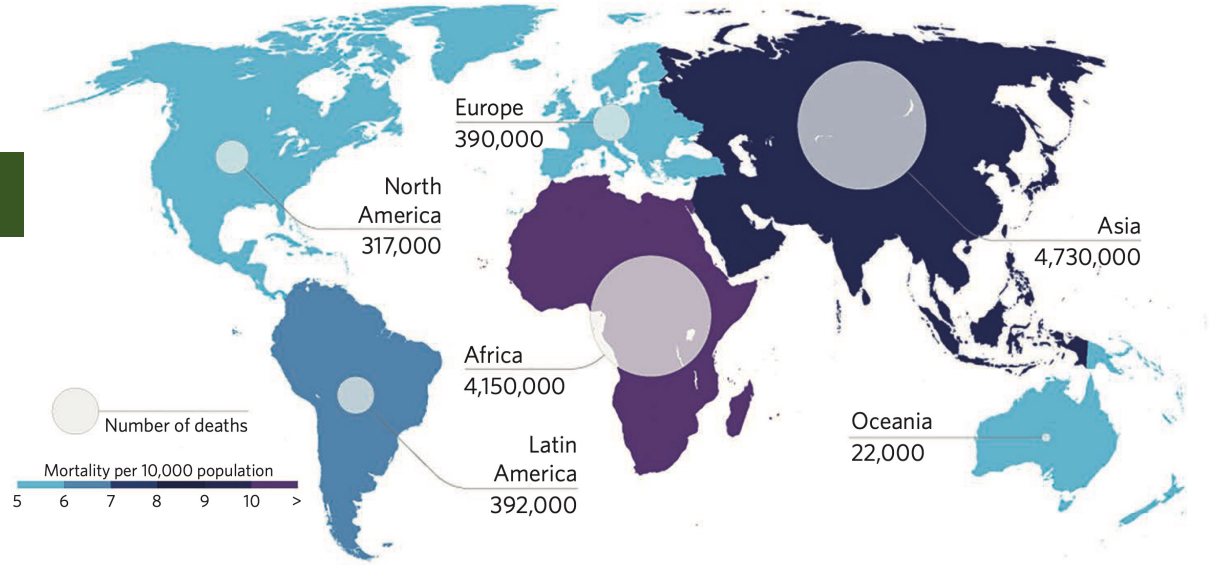

Fig 1. Deaths attributable to antimicrobial resistance every year by 2050.[1]

The problematic

- **Poorly biodegradable → accumulate**
- **↗ input → ↗ toxicological concerns**
- **Potential risks** to human health and aquatic life

[1] Sugden, R. *et al. Nature Microbiology* (2016).

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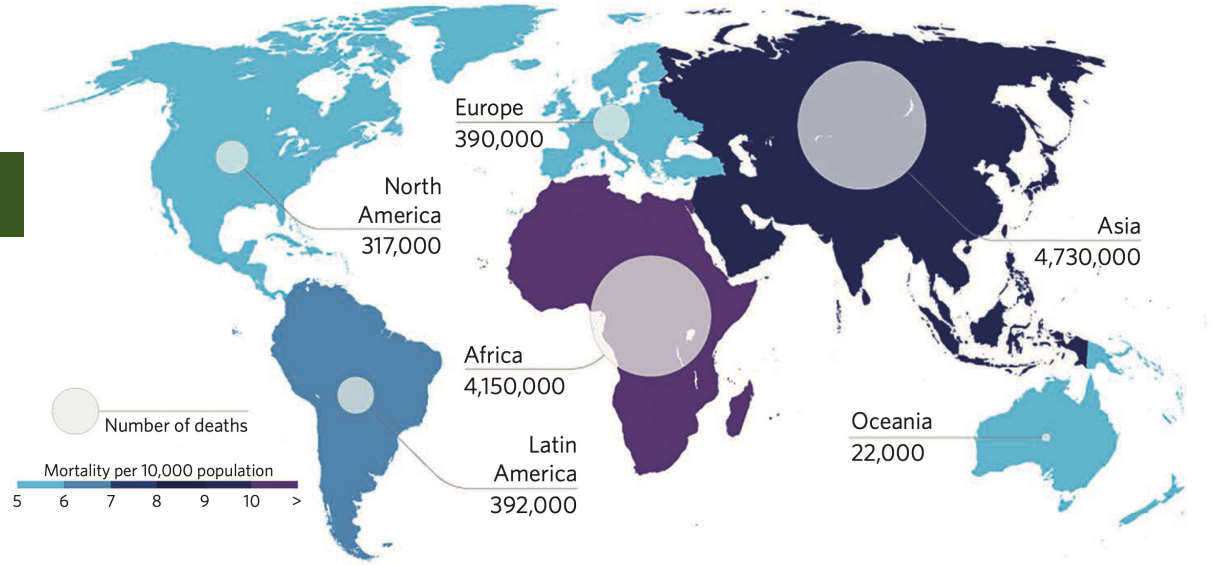

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Goal

❑ **Remediation processes**

→ Advanced Oxidation Processes (AOPs)

→ Exploring **Fenton-based reactions**

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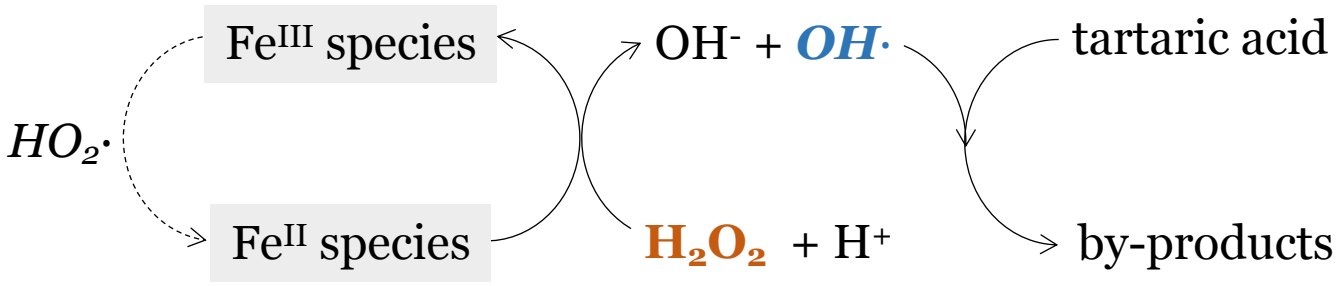
Fenton-based reactions

The classical reaction Fenton[2]



- Use of strong oxidants for *hydroxyl generation*

[2] Fenton, H. *Journal of the Chemical Society* (1894).

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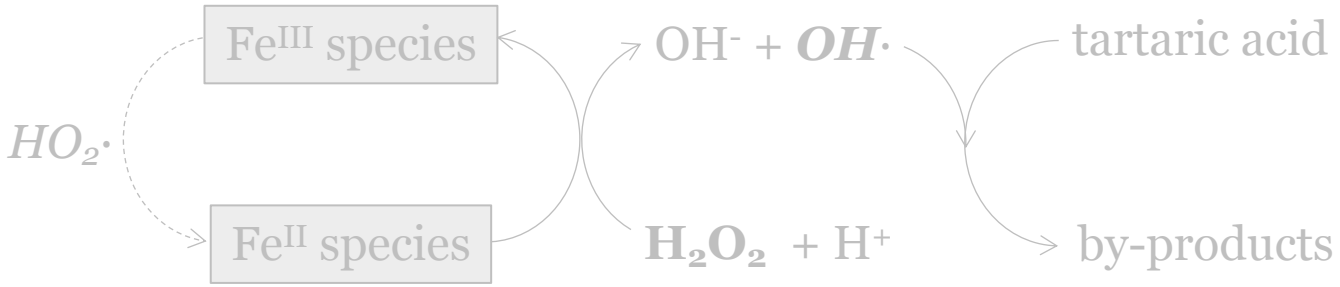

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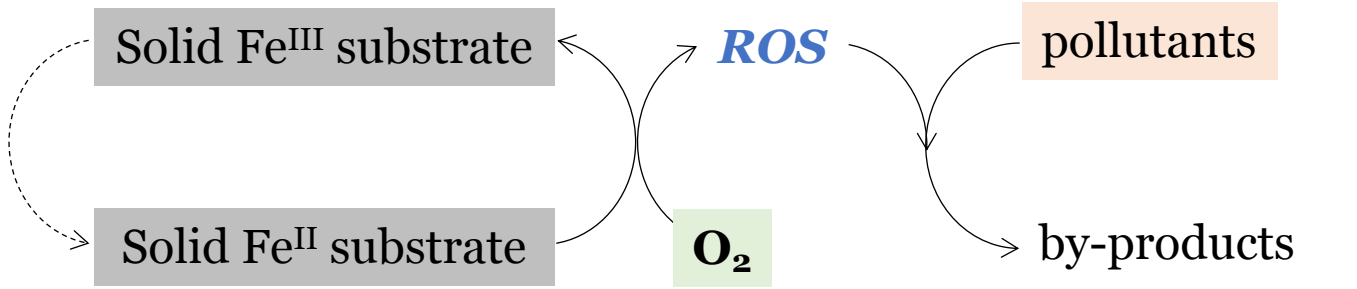
Target: a new eco-compatible process[3]



- Use of less aggressive oxidants for *Reactive Oxygen Species* generation

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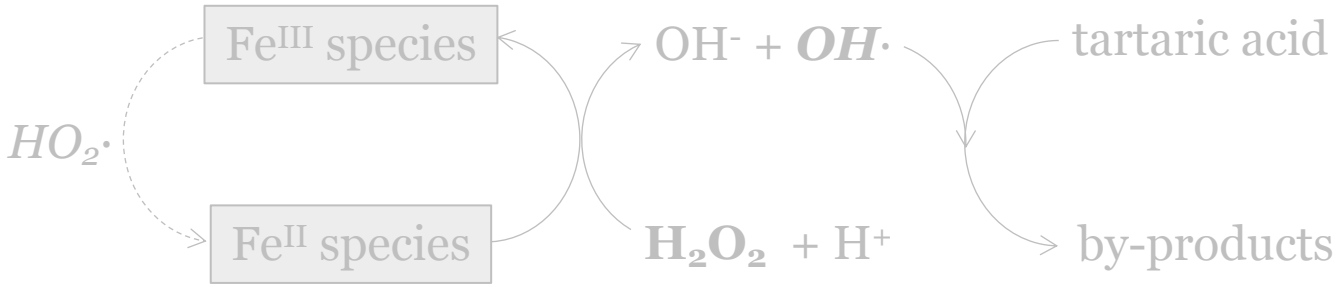

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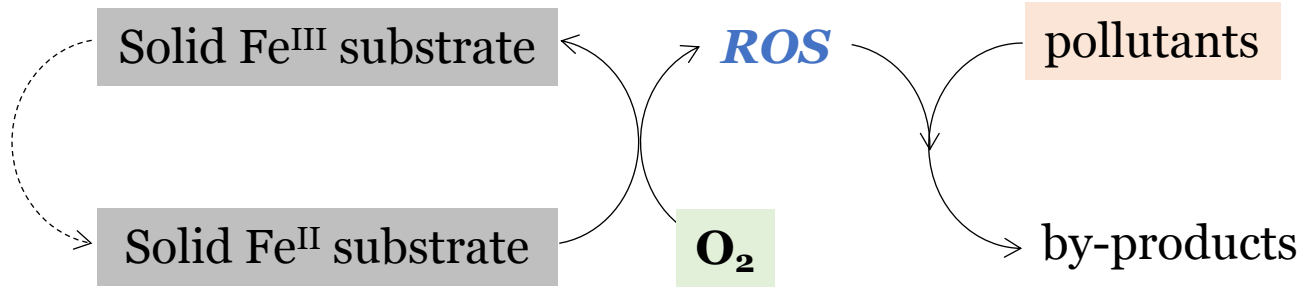
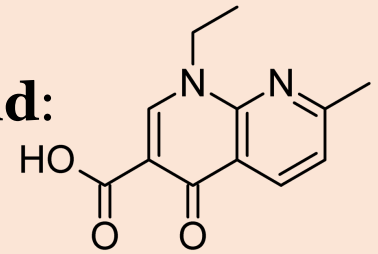


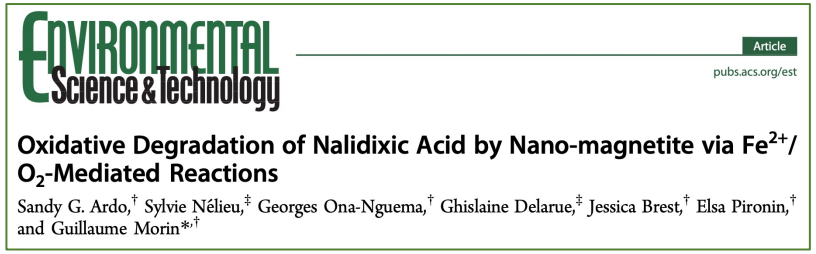
- Use of less aggressive oxidants for *Reactive Oxygen Species* generation

Oxygen: *oxidant agent* O_2

Nalidixic acid: *antibiotic*



Magnetite: *iron oxide* $(Fe^{2+}Fe_2^{3+})O_4$


Environmental Science & Technology — Article — pubs.acs.org/est

Oxidative Degradation of Nalidixic Acid by Nano-magnetite via Fe^{2+}/O_2-Mediated Reactions

Sandy G. Ardo,[†] Sylvie Nélieu,[‡] Georges Ona-Nguema,[†] Ghislaine Delarue,[‡] Jessica Brest,[†] Elsa Pironin,[†] and Guillaume Morin*[,†]

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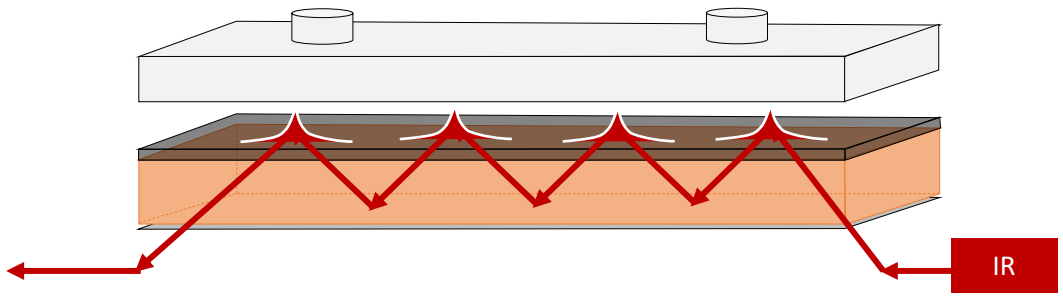
Objective → Obtain **kinetics information** and propose **mechanism**

Experimental:

→ Rapid Scan Infrared Spectroscopy in **Attenuated Total Reflectance** mode (ATR-FTIR)

ATR advantages:

- ✓ **Surface selective**
- ✓ Attenuates **strong signals** from liquid phase



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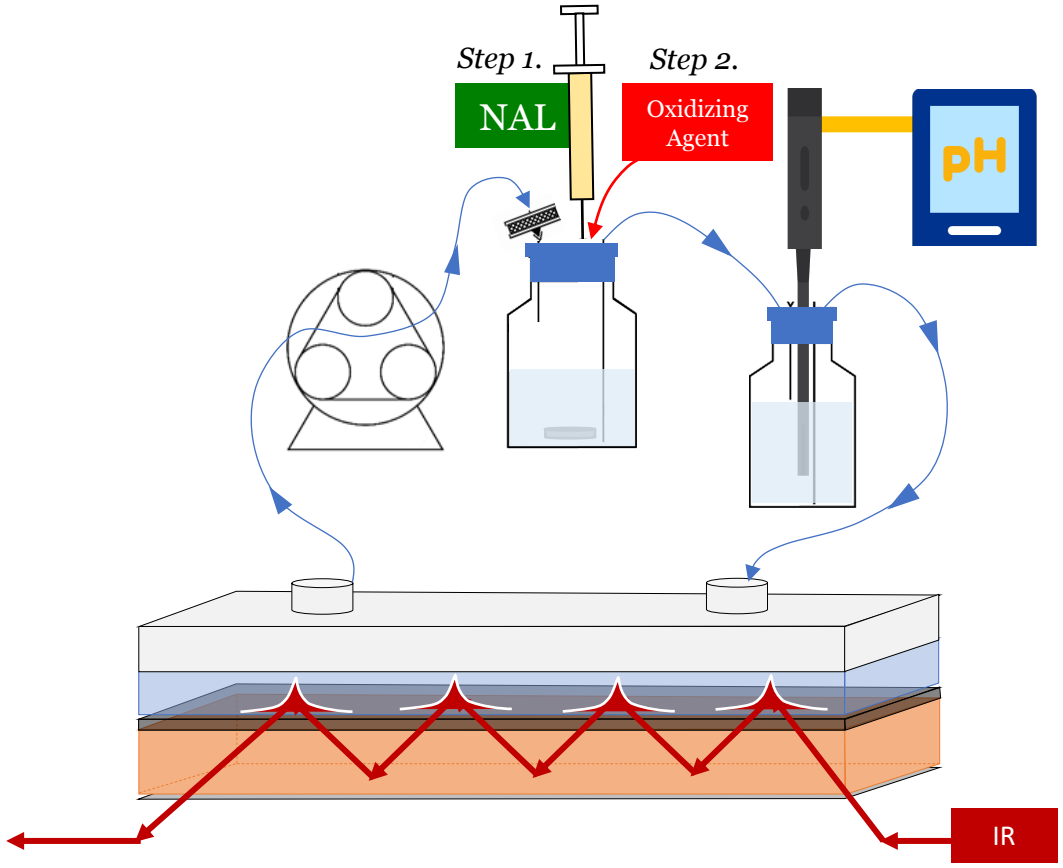

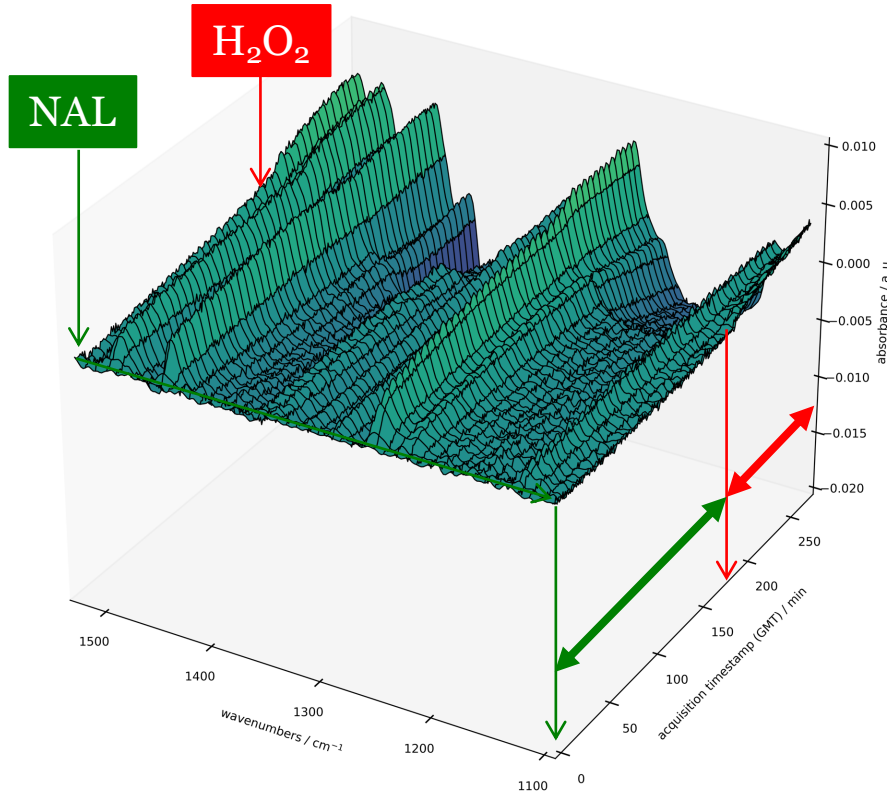

Fig. 4: Pollutants adsorption and reduction triggered by H_2O_2 (3h+1.5h)

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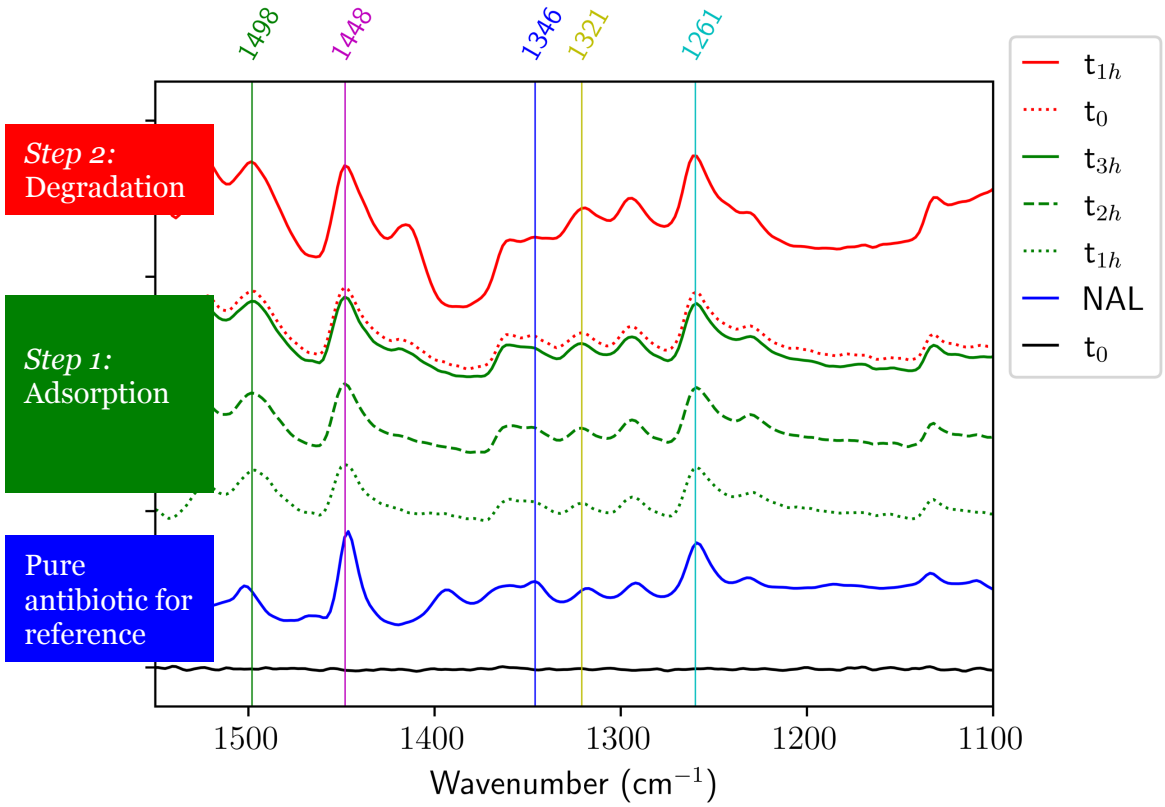


Next step:

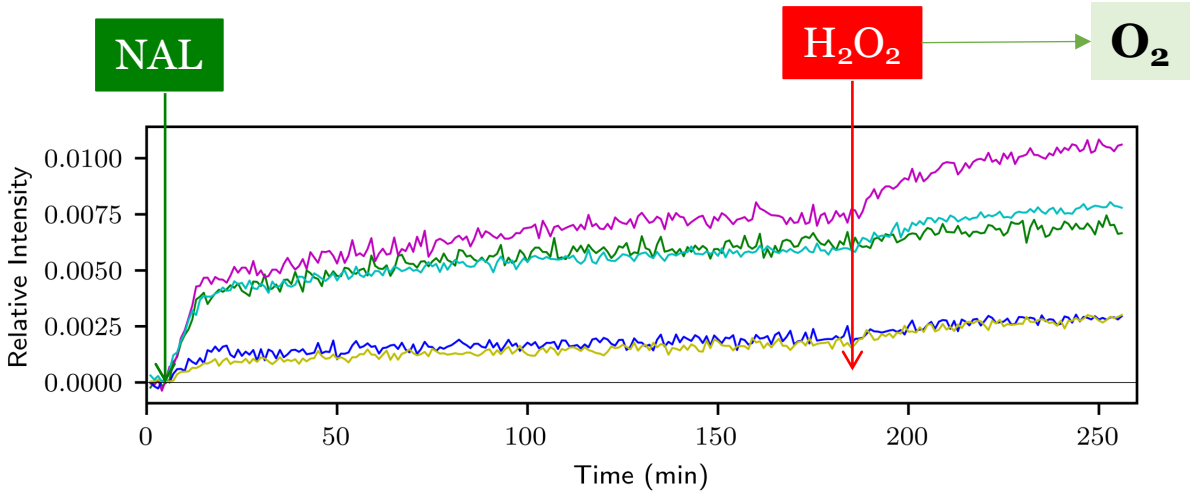


Fig. 5: Followed degradation kinetics after adsorption step.

Conclusions:

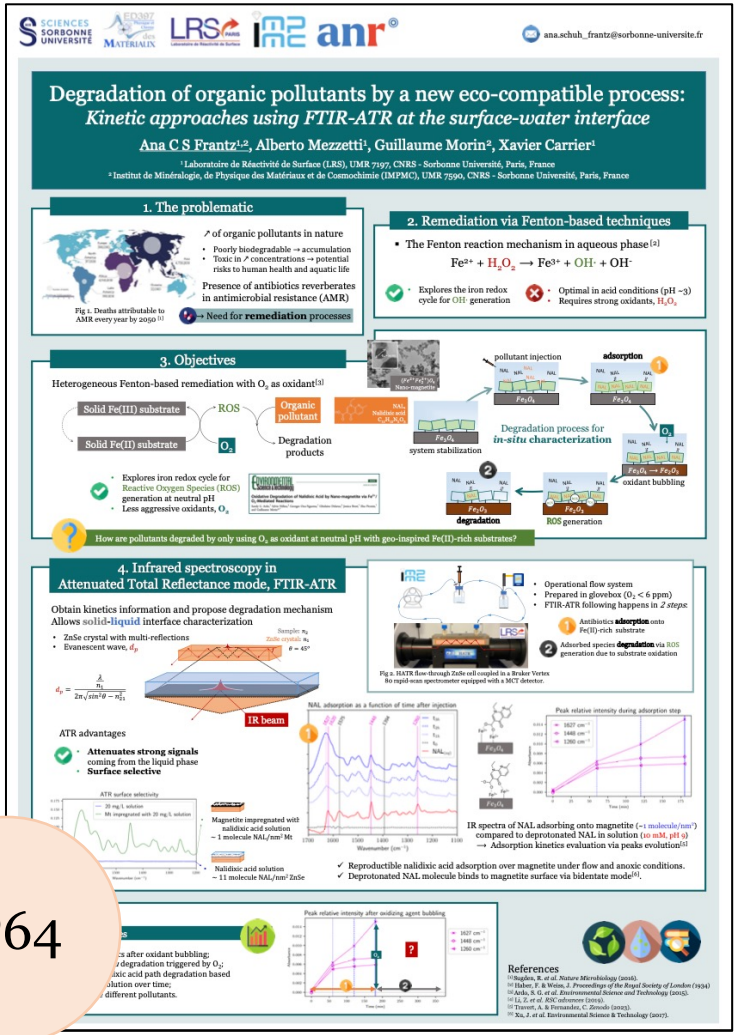
- ✓ Characterization protocol established;
- ✓ Full molecular assignment for adsorption;
- ✓ On-going experiments using O_2 as oxidizing agent;

Perspective:

- Propose reaction mechanism;
- Explore substrates/pollutants.

Thank you
for your attention!

Let's chat! n°64



2 & 3 November 2023