Degradation of organic pollutants by a new eco-compatible process
Molecular approach using FTIR-ATR at the surface-water interface

Ana Carolina SCHUH FRANTZ\textsuperscript{1,2}

Alberto MEZZETTI\textsuperscript{1}, Guillaume MORIN\textsuperscript{2}, Xavier CARRIER\textsuperscript{1}

\textsuperscript{1}Laboratoire de Réactivité de Surface, LRS
\textsuperscript{2}Institut de Minéralogie, de Physique des Matériaux et de Cosmochimie, IMPMC

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Our motivation

Increase of **organic pollutants** in nature

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

- Poorly biodegradable $\rightarrow$ accumulate
- $\uparrow$ input $\rightarrow$ $\uparrow$ toxicological concerns
- Potential risks to human health and aquatic life

Fig 1. Deaths attributable to antimicrobial resistance every year by 2050.$^1$

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Goal

- **Remediation processes** → Advanced Oxidation Processes (AOPs)
  → Exploring Fenton-based reactions

Fig 1. Deaths attributable to antimicrobial resistance every year by 2050.¹

The classical reaction Fenton²

\[
\begin{align*}
\text{Fe}^{\text{III}} \text{ species} & \xrightarrow{\text{HO}_2^\cdot} \text{OH}^- + \text{OH}^\cdot \xrightarrow{\text{tartaric acid}} \\
\text{Fe}^{\text{II}} \text{ species} & \xrightarrow{\text{H}_2\text{O}_2 + \text{H}^+} \xrightarrow{\text{by-products}}
\end{align*}
\]

- Use of strong oxidants for hydroxyl generation

² Fenton, H. Journal of the Chemical Society (1894).
Fenton-based reactions

The classical reaction Fenton\(^2\)

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- Use of strong oxidants for hydroxyl generation

Target: a new eco-compatible process\(^3\)

\[
\begin{align*}
\text{Solid Fe}^{III}_\text{substrate} & \quad \text{ROS} & \quad \text{pollutants} \\
& \quad \text{O}_2 & \quad \text{by-products}
\end{align*}
\]

- Use of less aggressive oxidants for Reactive Oxygen Species generation

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\(^2\) Fenton, H. *Journal of the Chemical Society* (1894).
\(^3\) Ardo, S. *et al.* *Environmental Science & Technology* (2015).
**Fenton-based reactions**

**The classical reaction Fenton**

- $\text{Fe}^{III}$ species $\rightarrow \text{OH}^- + \text{OH}^-$ (tartaric acid)
- $\text{Fe}^{II}$ species $\rightarrow \text{H}_2\text{O}_2 + \text{H}^+$ (by-products)

- Use of strong oxidants for *hydroxyl generation*

**Target: a new eco-compatible process**

- $\text{Solid Fe}^{III}$ substrate $\rightarrow \text{ROS}$ (pollutants)
- $\text{Solid Fe}^{II}$ substrate $\rightarrow \text{O}_2$ (by-products)

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

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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
**Introduction & Objective**

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

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

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**Step 1.**

NAL

**Step 2.**

Oxidizing Agent

**pH**

**Fig. 4:** Pollutants adsorption and reduction triggered by H$_2$O$_2$ (3h+1.5h)
Objective → Obtain **kinetics information** and propose **mechanism**

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

**Introduction & Objective**

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

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

**Experimental & (Partial) Results**

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

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

**Conclusions & Perspectives**

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

→ **Rapid Scan Infrared Spectroscopy in Attenuated Total Reflectance** mode (ATR-FTIR)
Conclusions:
- Characterization protocol established;
- Full molecular assignment for adsorption;
- On-going experiments using O₂ as oxidizing agent;

Perspective:
- Propose reaction mechanism;
- Explore substrates/pollutants.

Thank you for your attention!

Let’s chat!