Synthesis of innovative and bio-based materials for bacterial depollution

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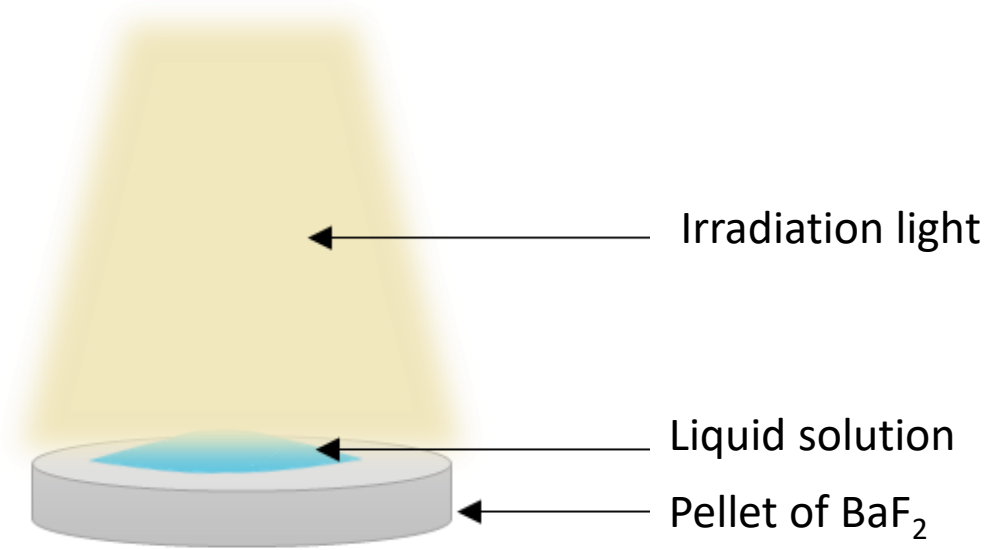
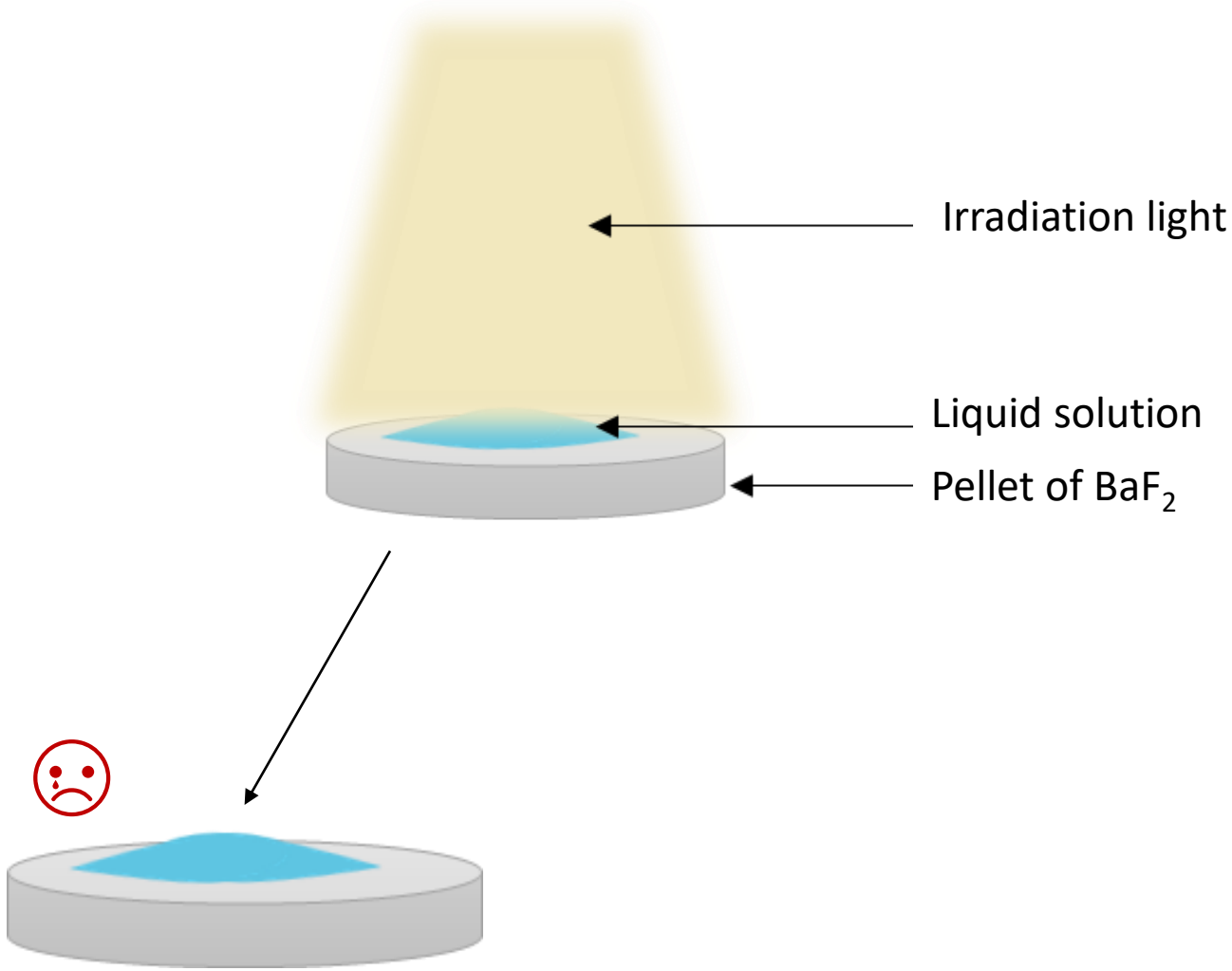

Irradiation light
Liquid solution
Pellet of BaF_2



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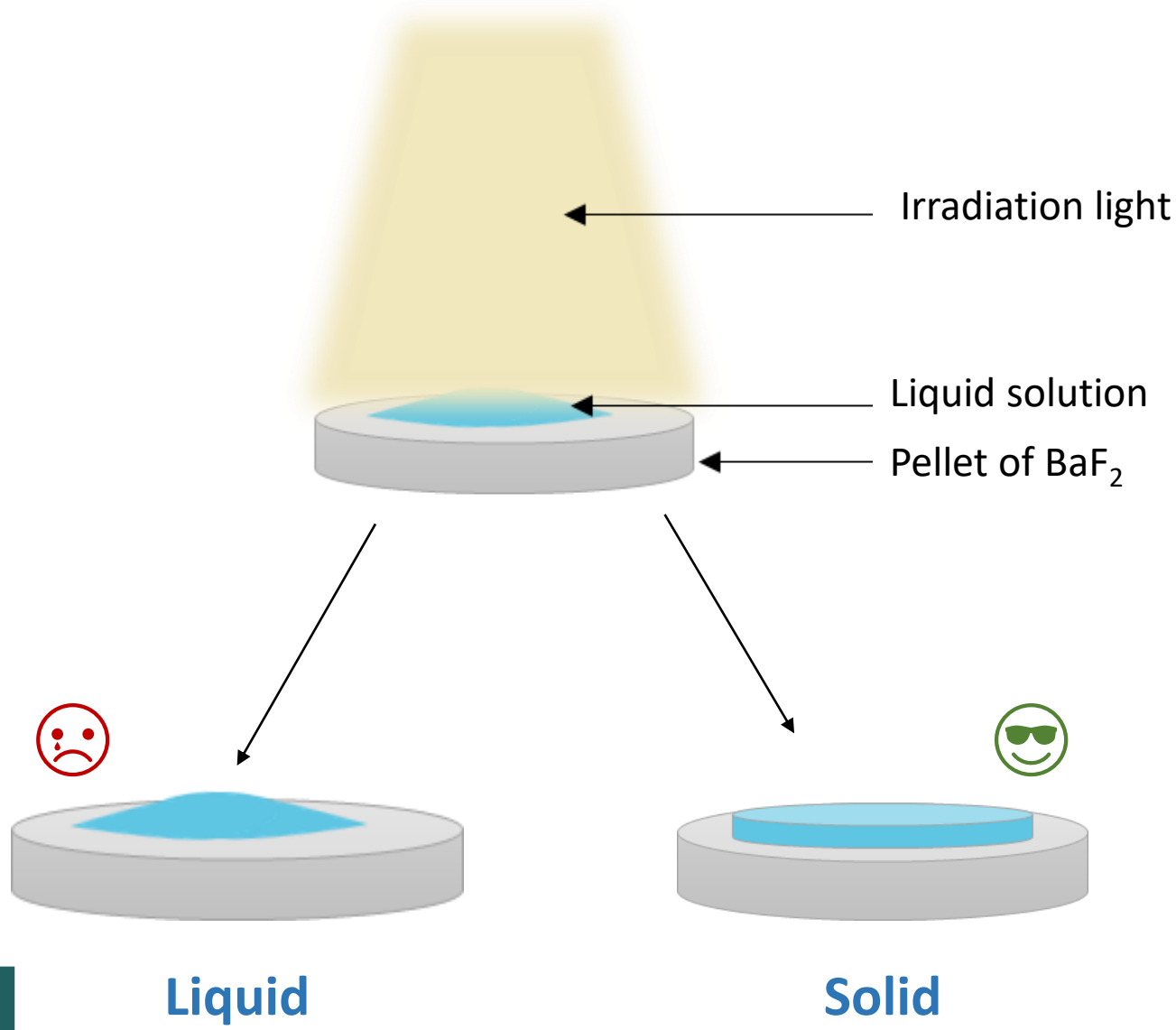
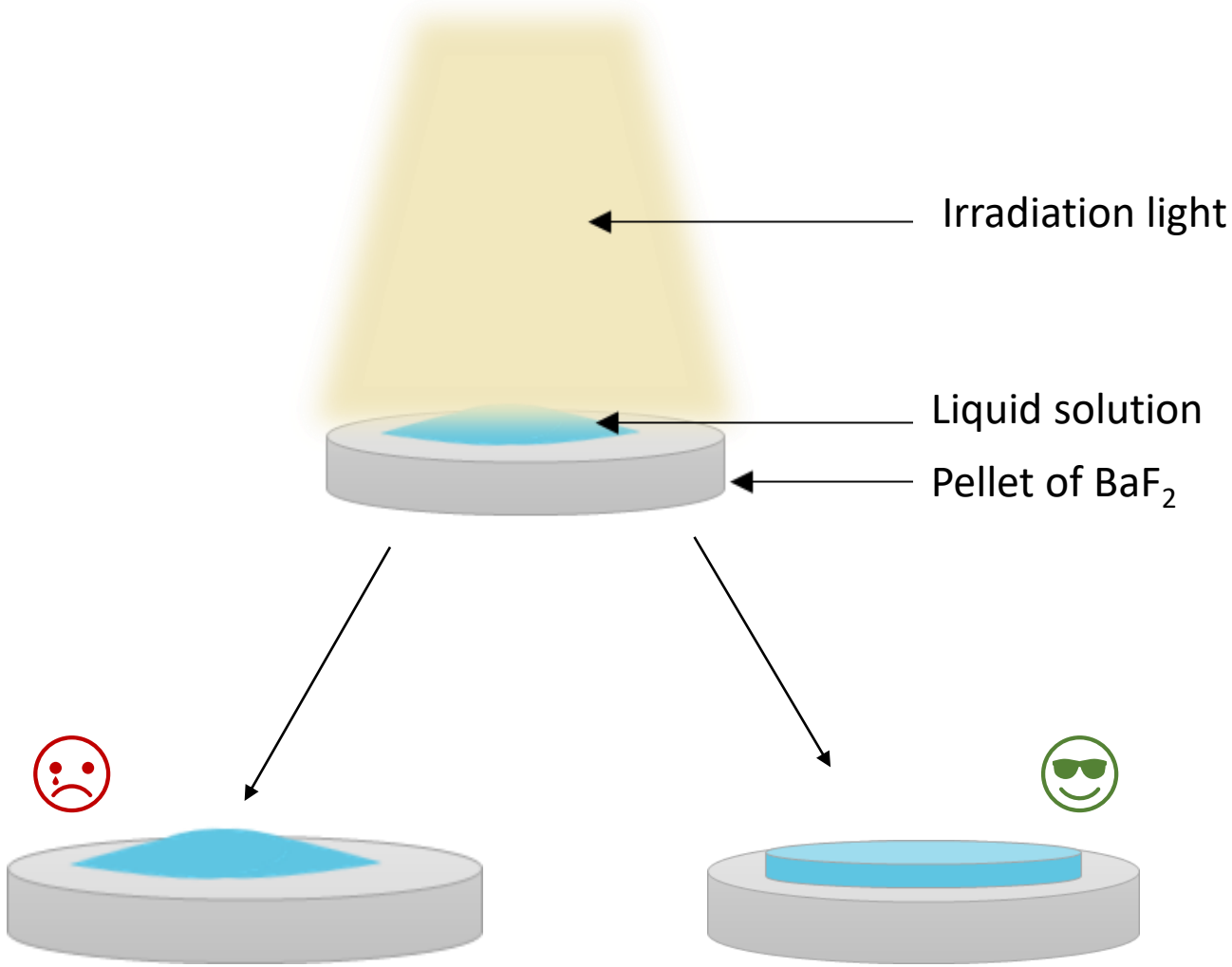
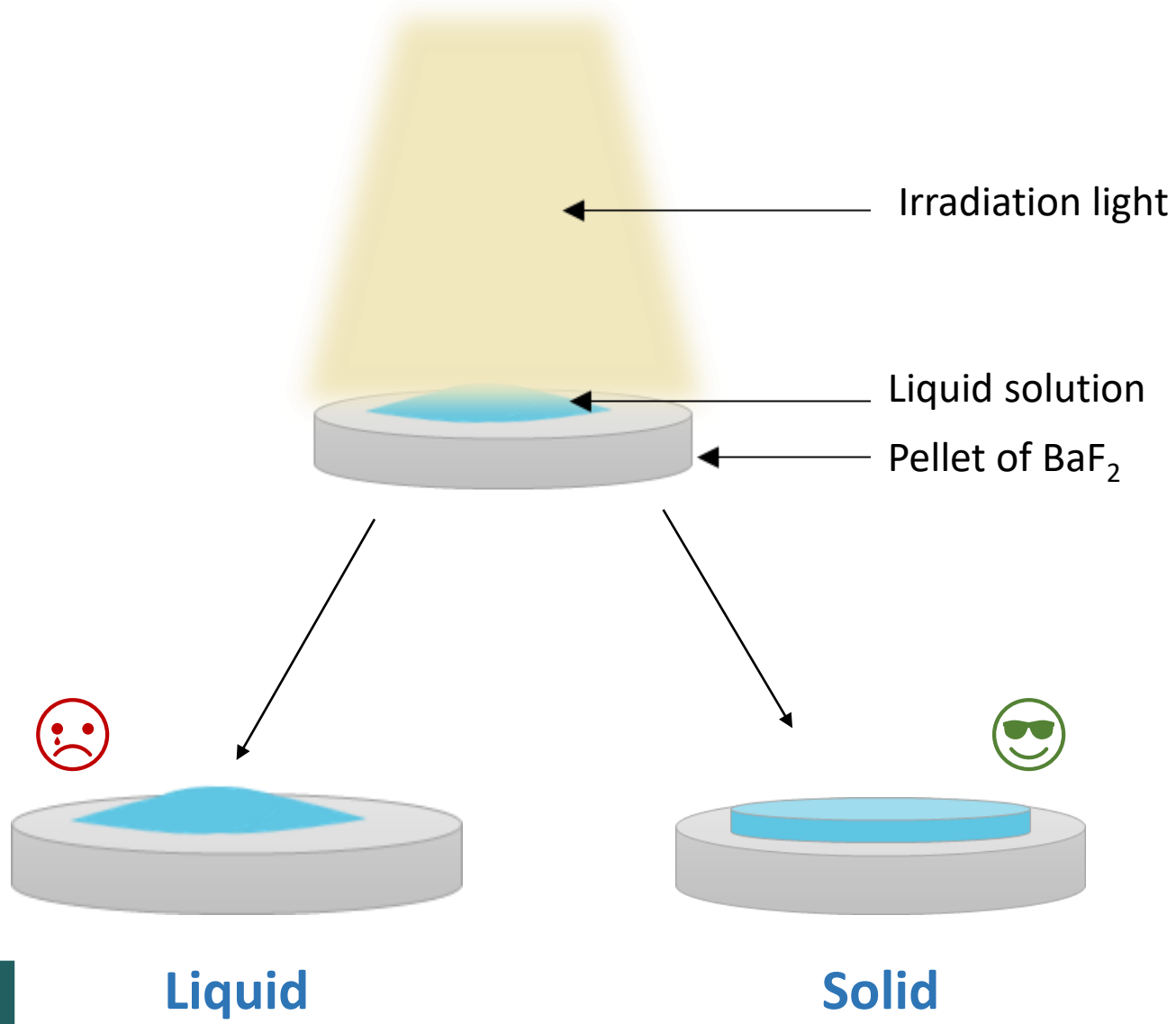

Irradiation light
Liquid solution
Pellet of BaF_2
Liquid
Solid



Drawbacks

X Currently: UV sources

X Bad for the environment and the operator



Drawbacks

X Currently: UV sources

X Bad for the environment and the operator

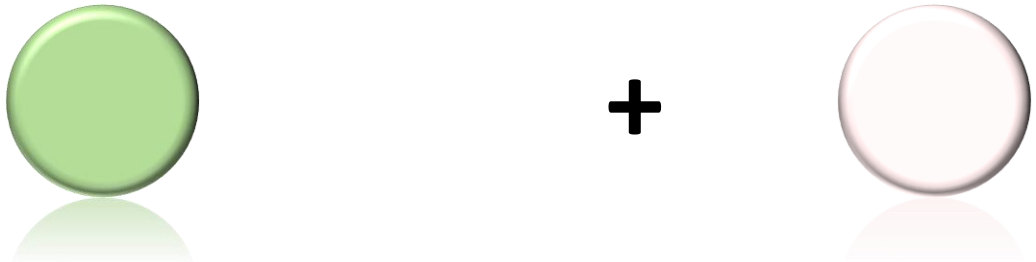
Advantages:

✓ Solvent-free

✓ No heating

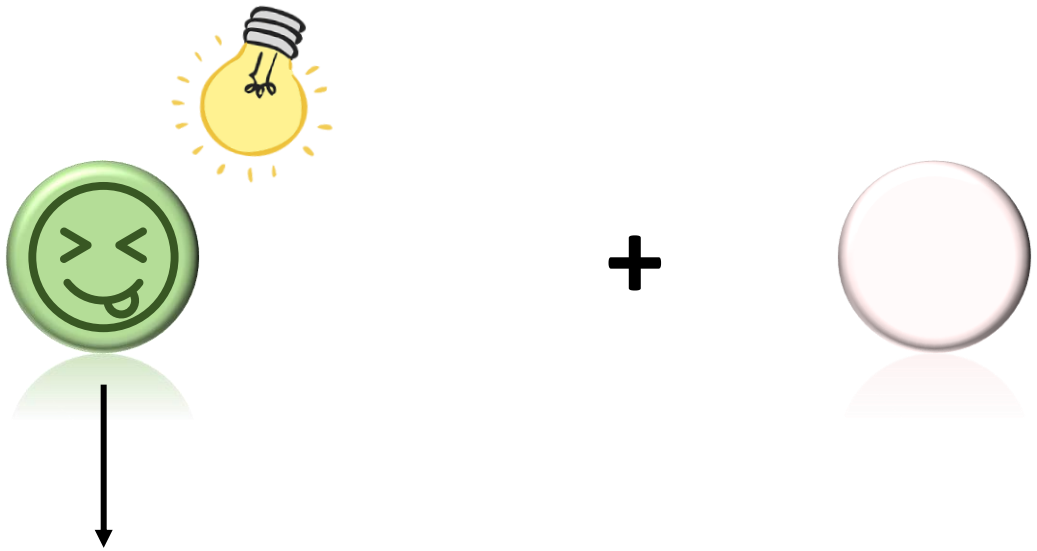
✓ Economical and environmentally friendly

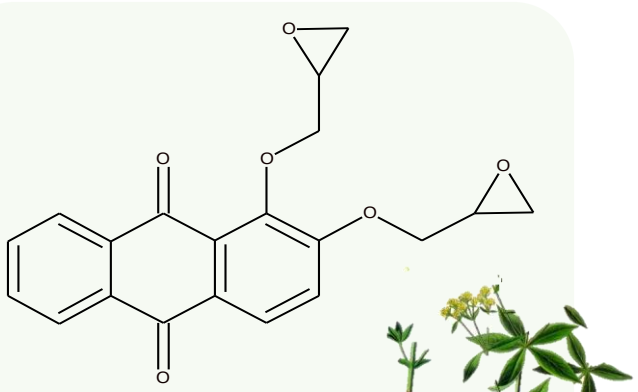
Polymer:



Polymer:

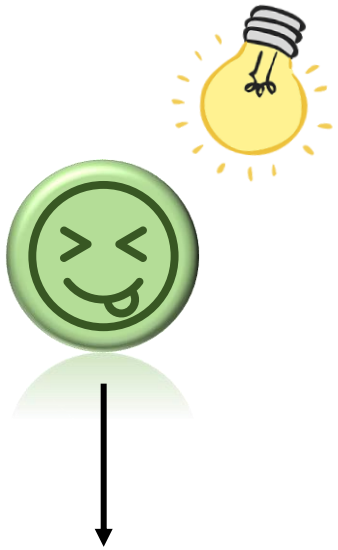
Polymer:





Alizarin epoxidized

Polymer:



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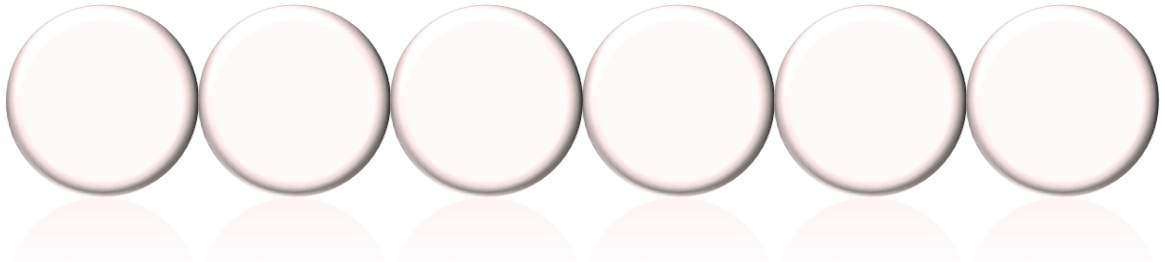

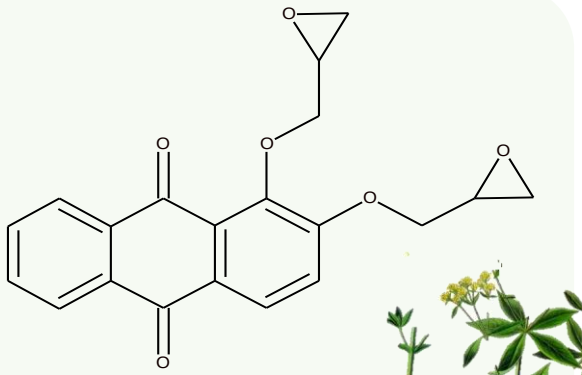

Alizarin epoxidized

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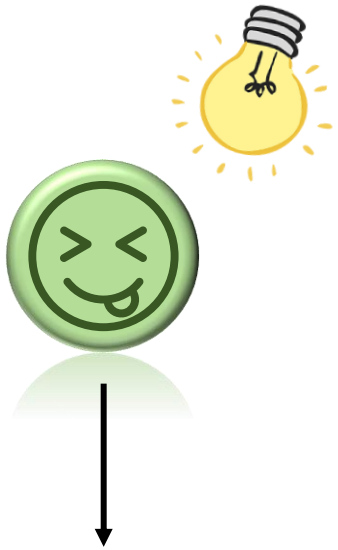

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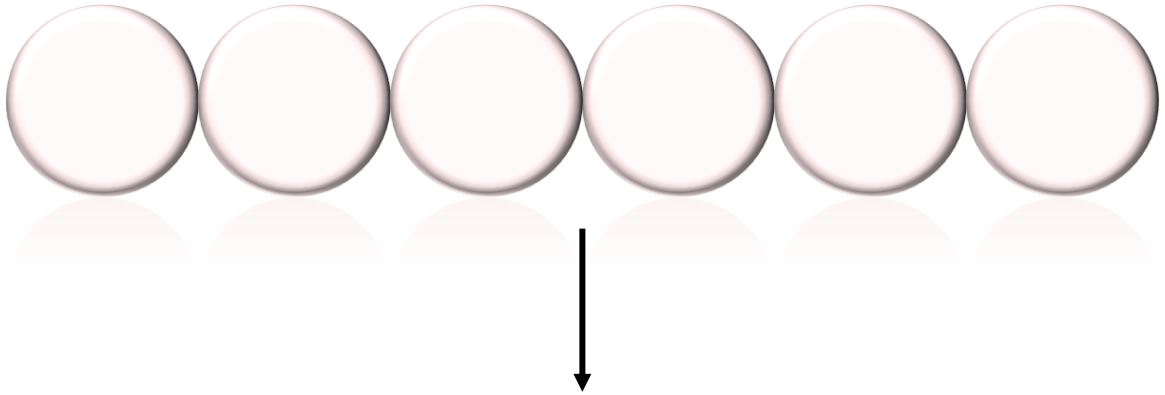

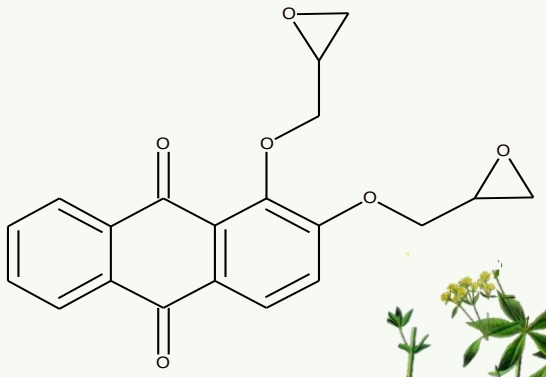

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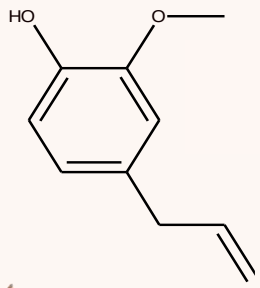

Eugenol

Polymer:

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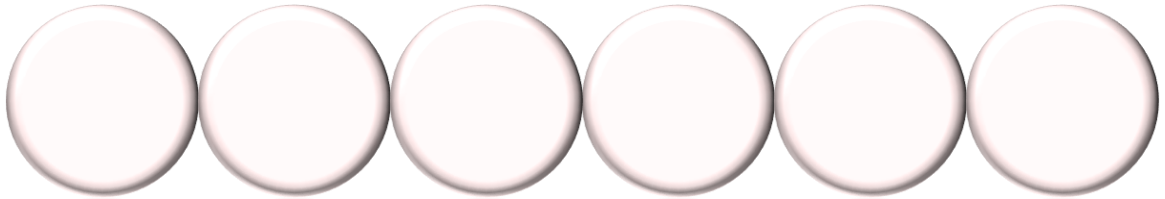

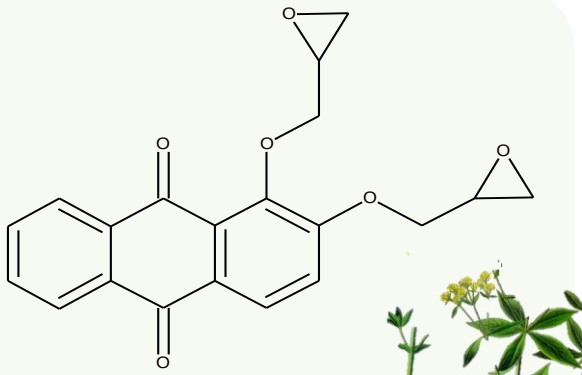

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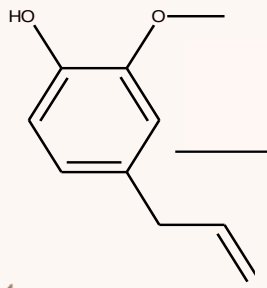
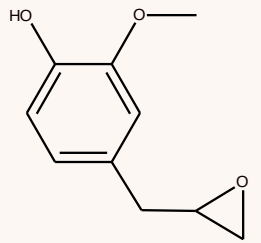
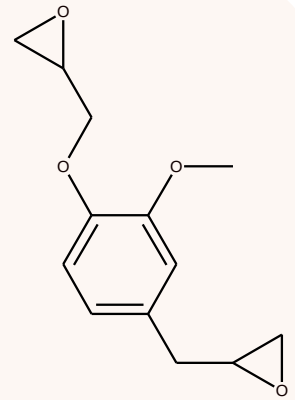


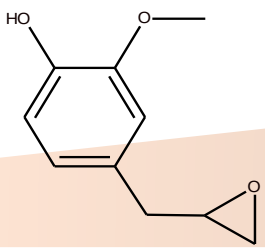
Eugenol



Mono- epoxidized Eugenol



Di- epoxidized Eugenol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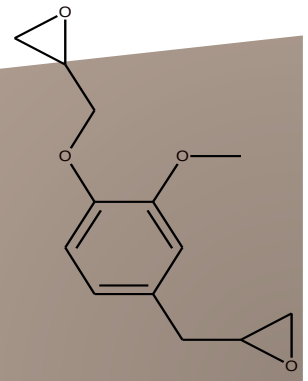
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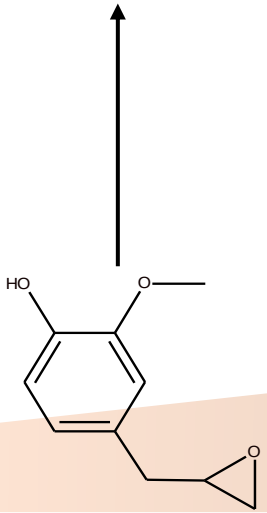
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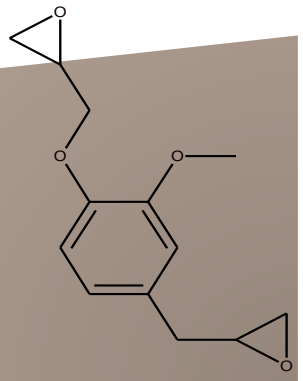
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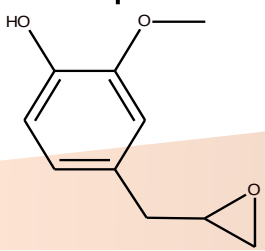
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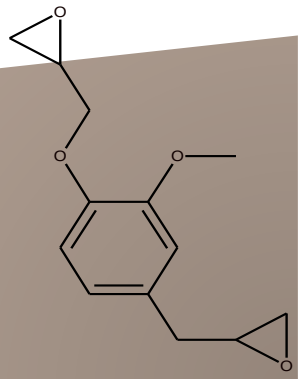
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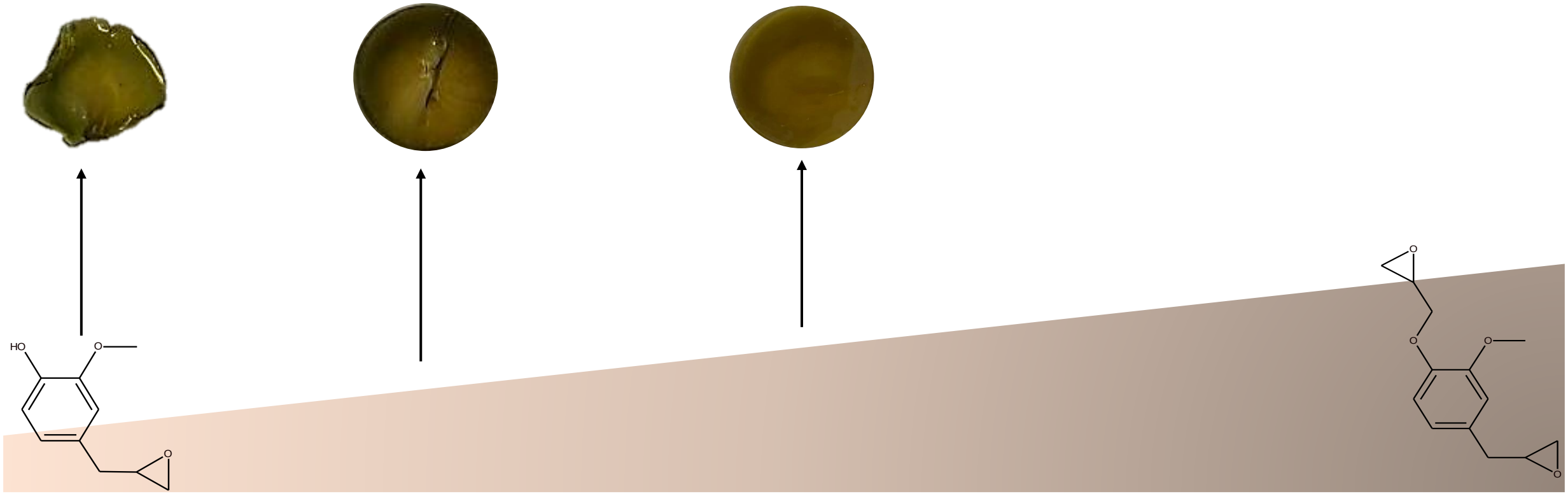
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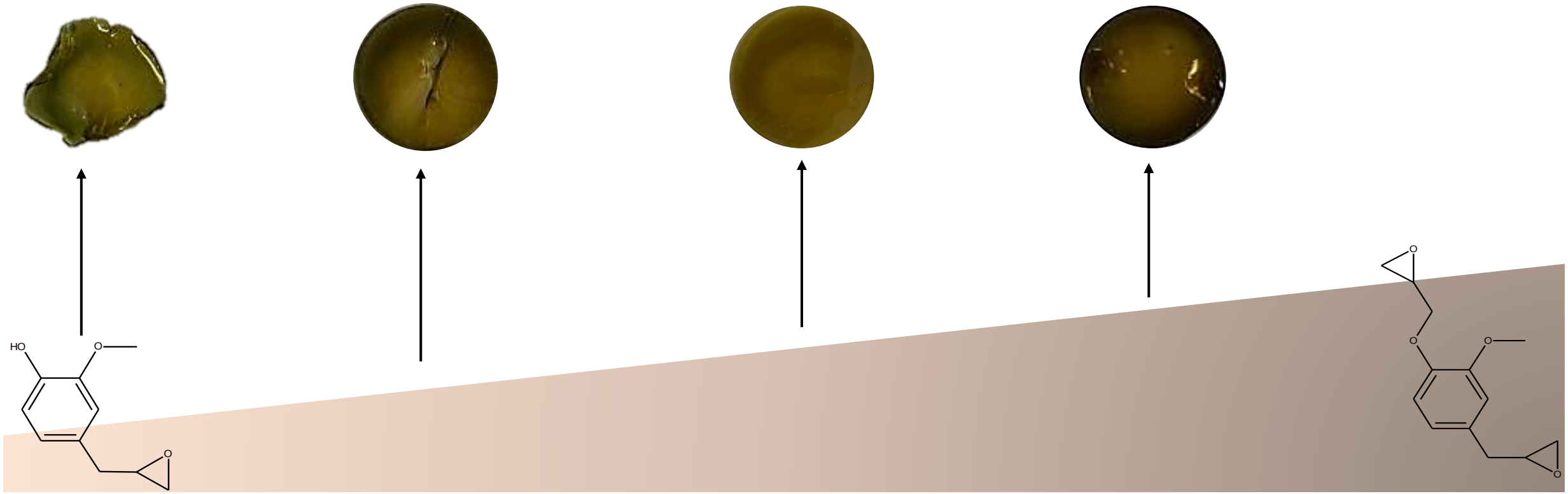
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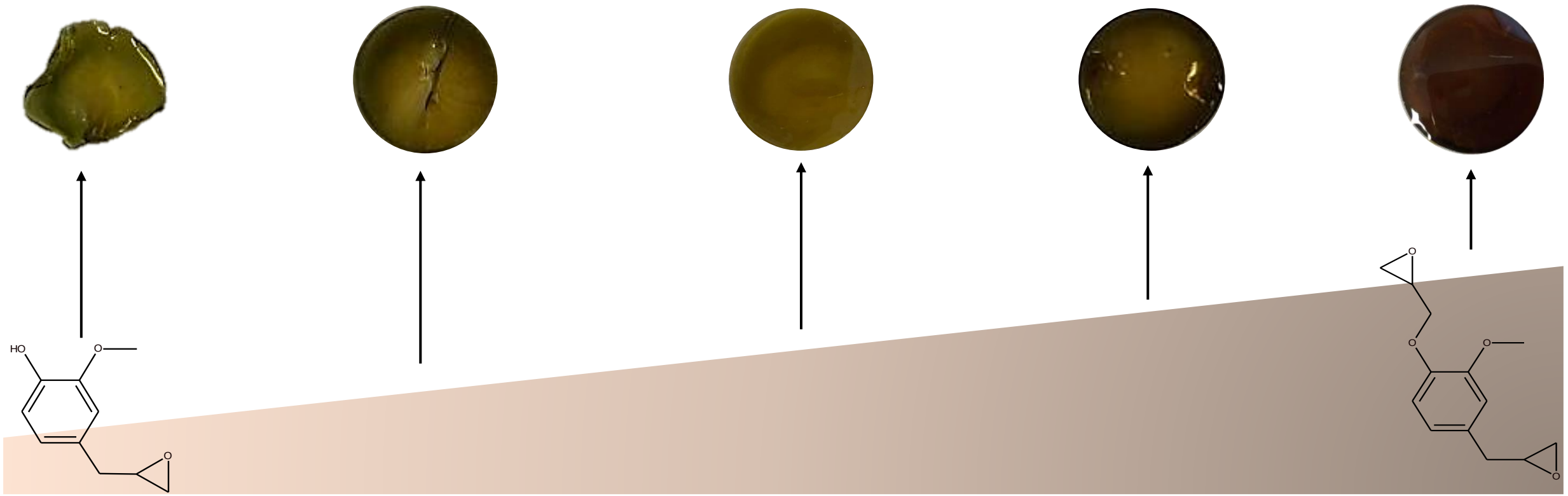
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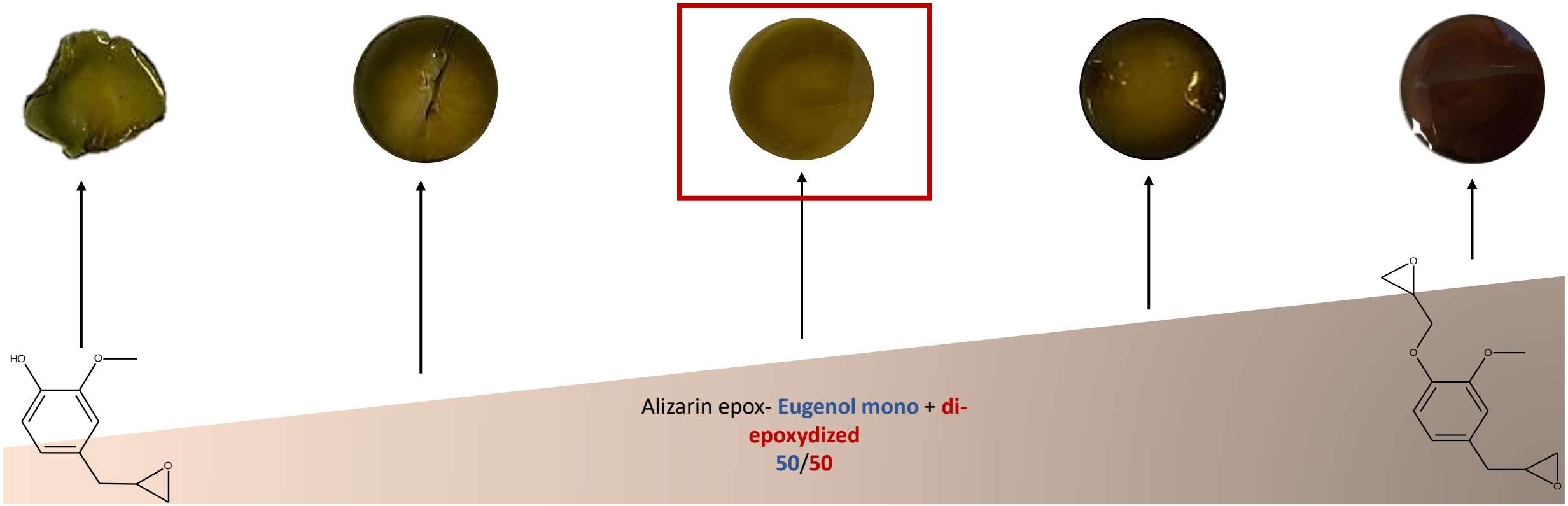
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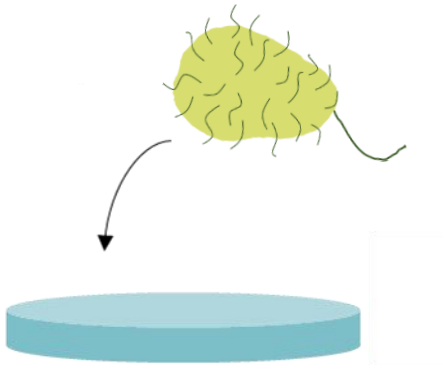
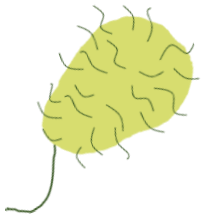
Alizarin epox- Eugenol mono + di-epoxydized
50/50

Antibacterial properties:



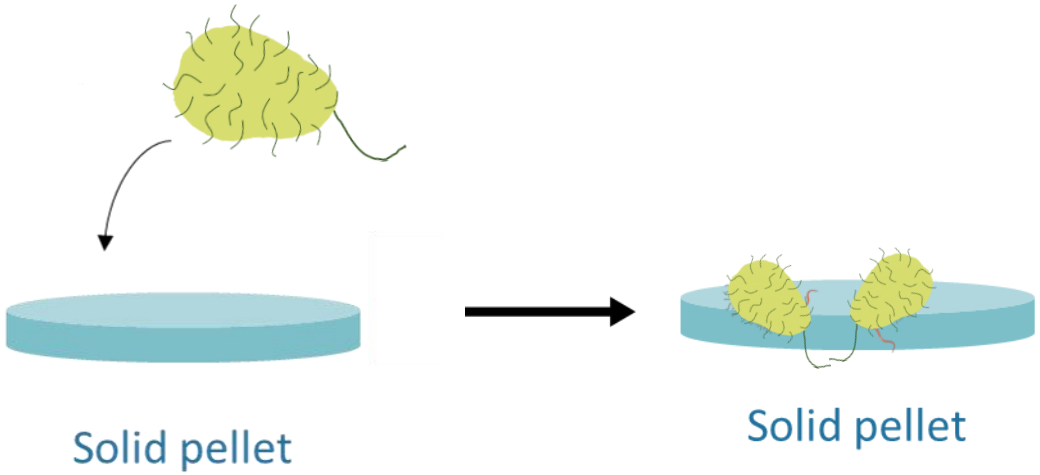
Solid pellet

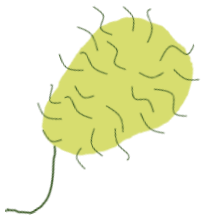
Incubation with bacteria



Bacteria strains:
Staphylococcus aureus
Escherichia coli

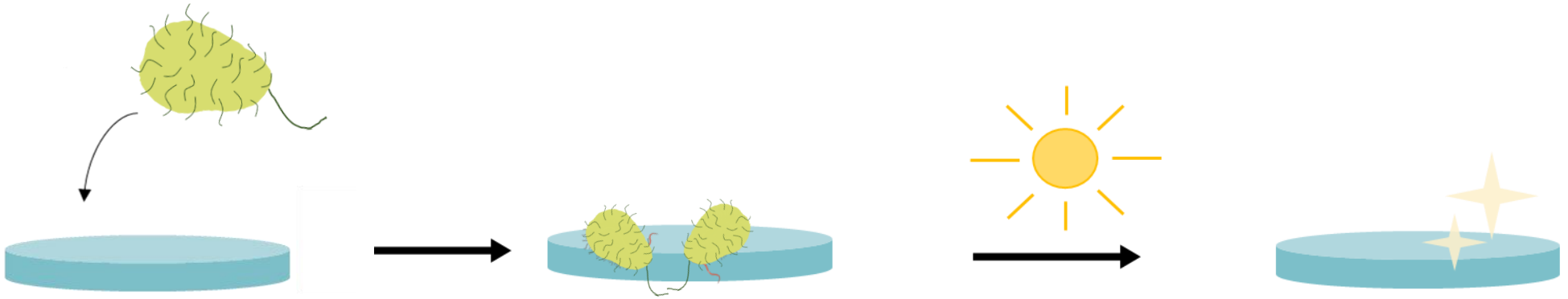
Antibacterial properties:

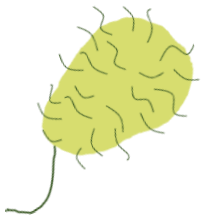




Bacteria strains:
Staphylococcus aureus
Escherichia coli

Antibacterial properties:





Bacteria strains:
Staphylococcus aureus
Escherichia coli

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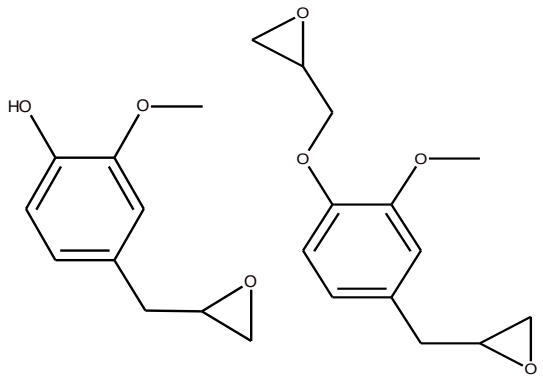

Alizarin epox- **Eugenol mono**
+ **di-epoxydized**
50/**50**

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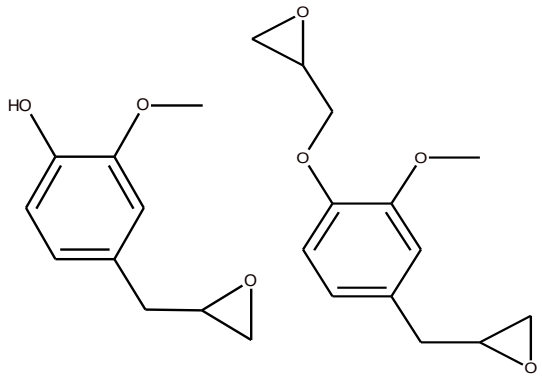
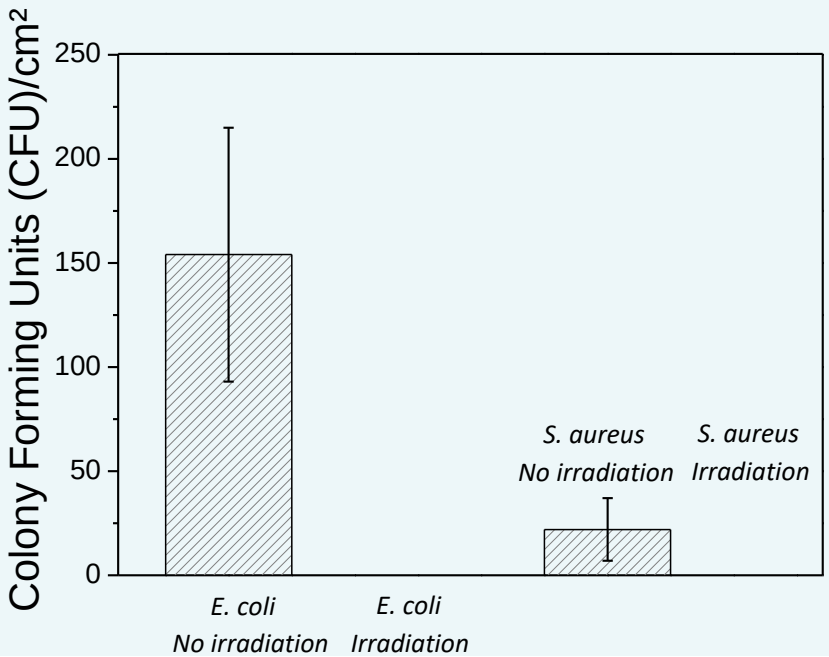


Alizarin epox- **Eugenol mono** + **di-epoxydized** **50**/**50**

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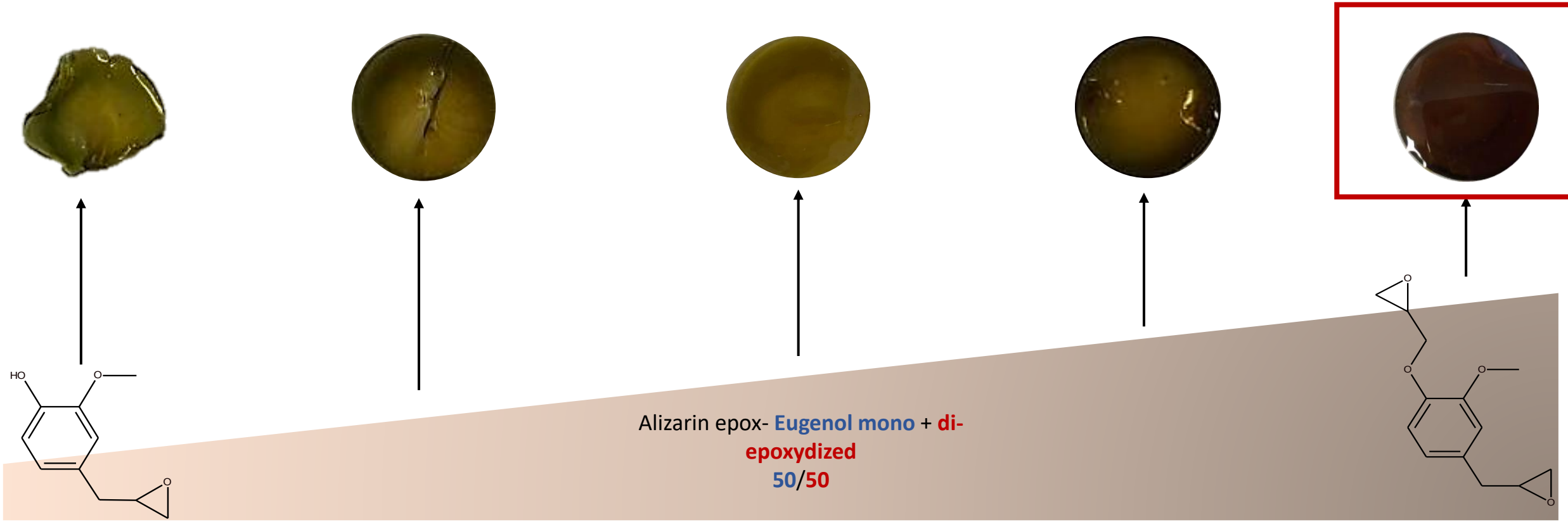
Alizarin epox- Eugenol mono + di-epoxydized
50/50



Alizarin epox- **Eugenol mono** + **di-epoxydized**
50/**50**

Alizarin epox- **Eugenol di-epoxidized**
100

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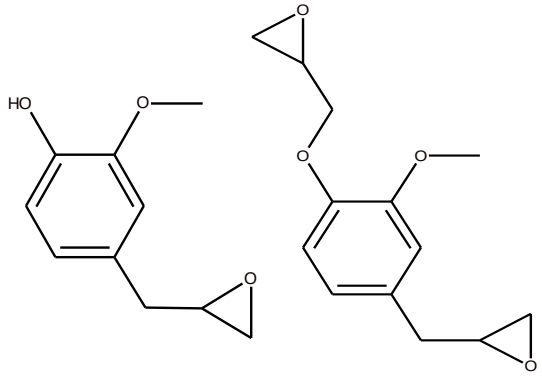
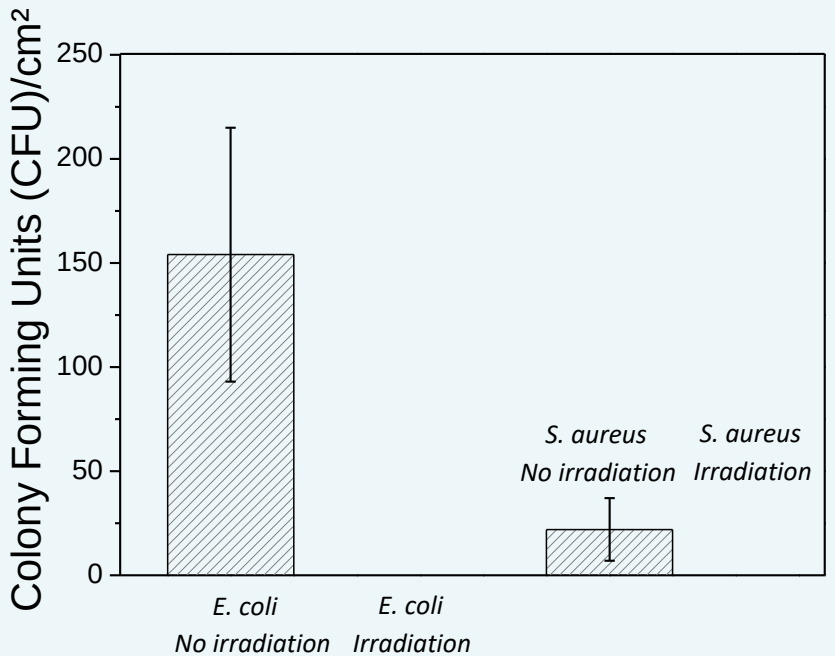


Alizarin epox- **Eugenol mono** + **di-epoxydized** **50**/**50**



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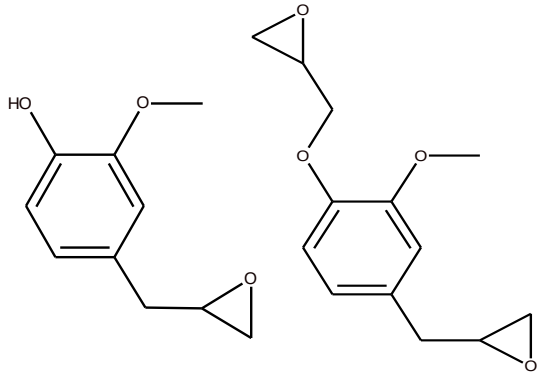
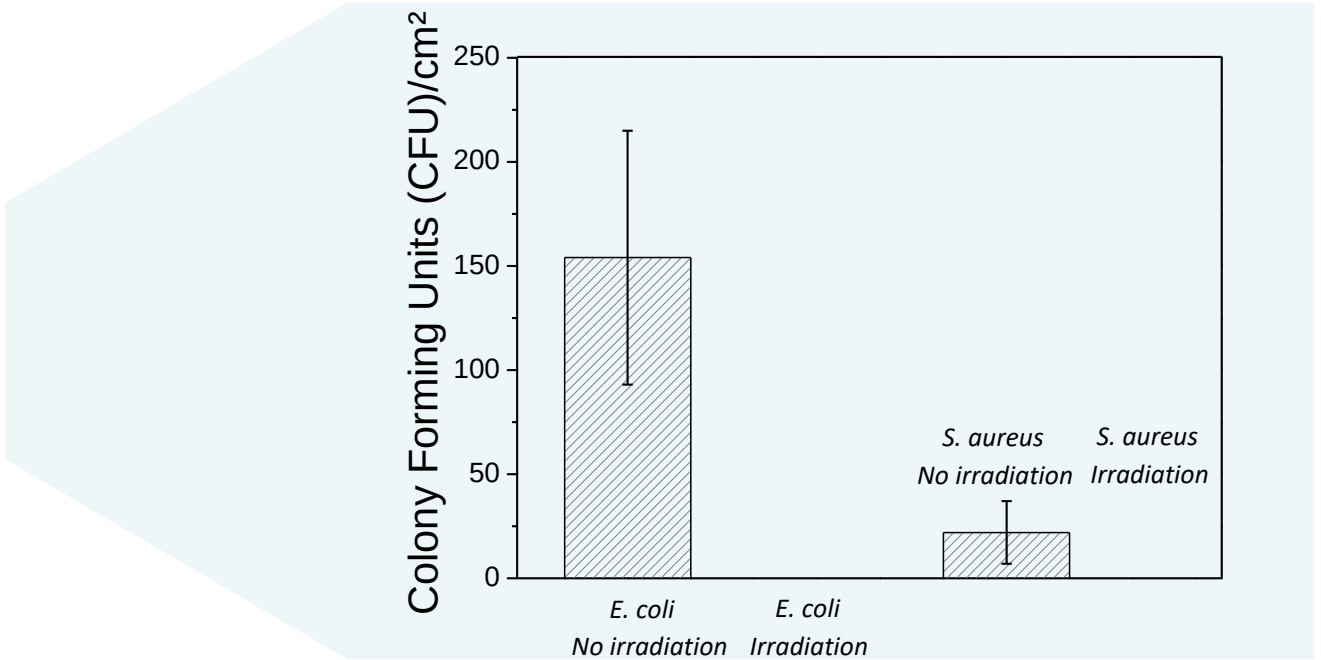
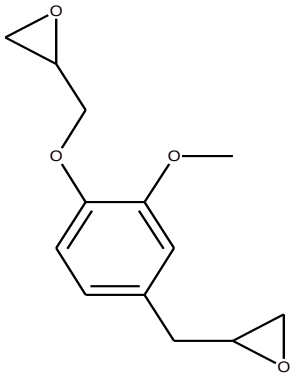


Alizarin epox- **Eugenol mono + di-epoxydized 50/50**



Alizarin epox- **Eugenol di-epoxidized 100**



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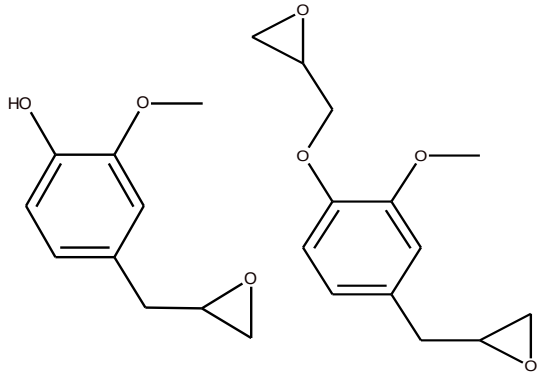
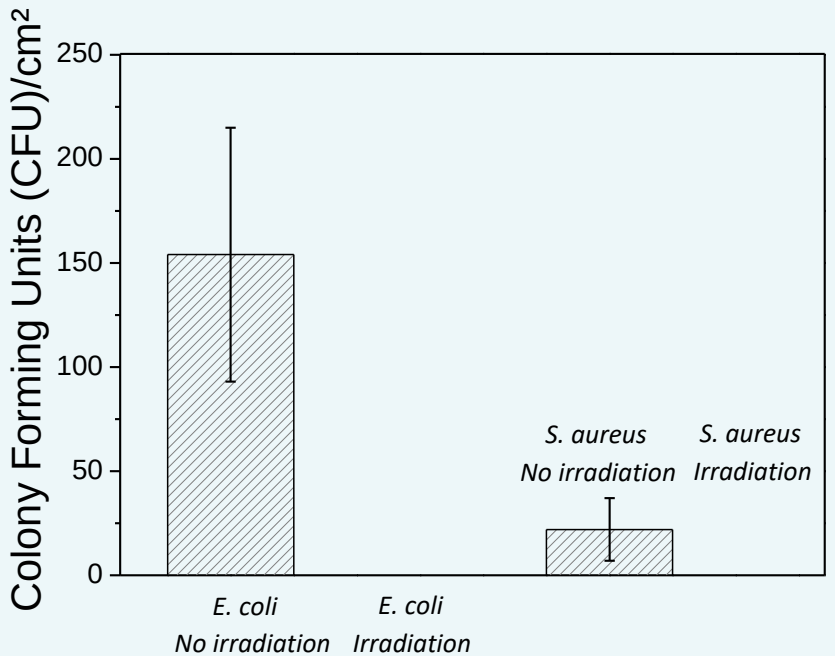
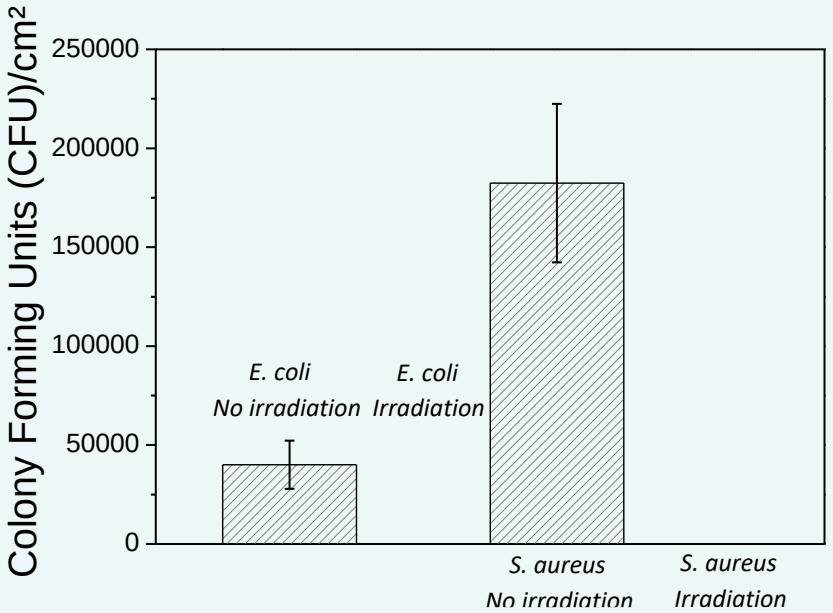
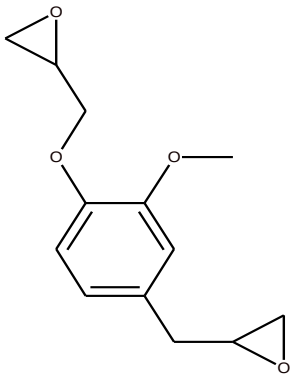


Alizarin epox- **Eugenol mono + di-epoxydized**
50/50



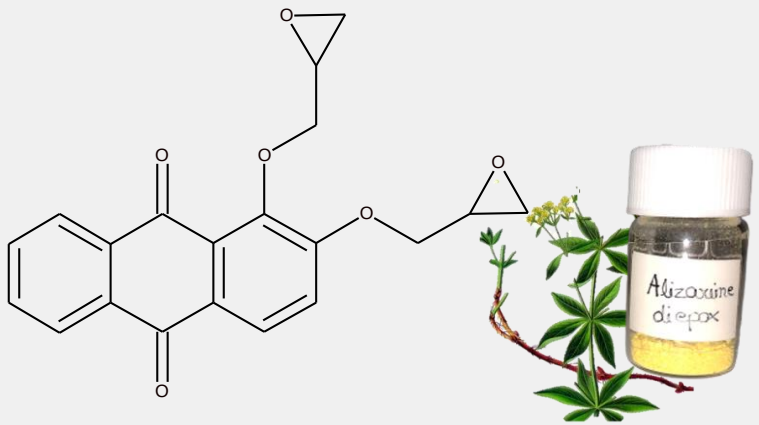


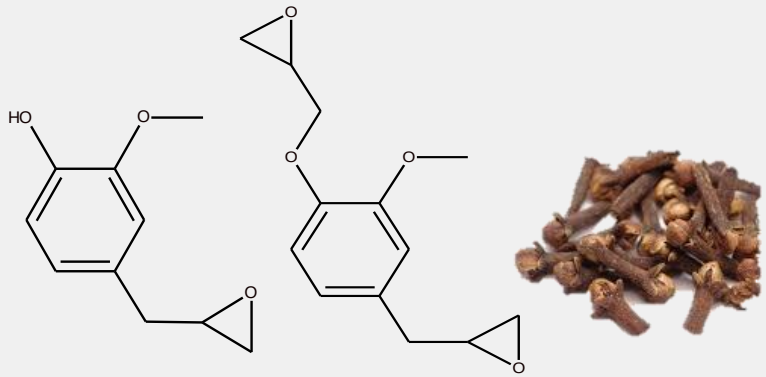
Alizarin epox- **Eugenol di-epoxidized**
100



Conclusion:

Biological resources

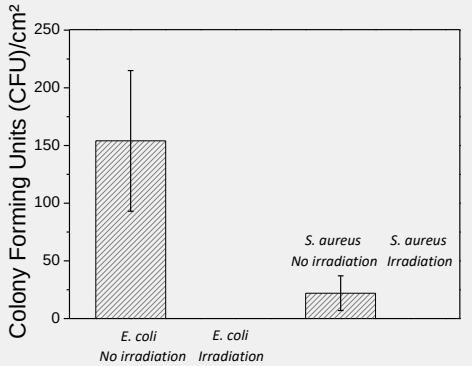


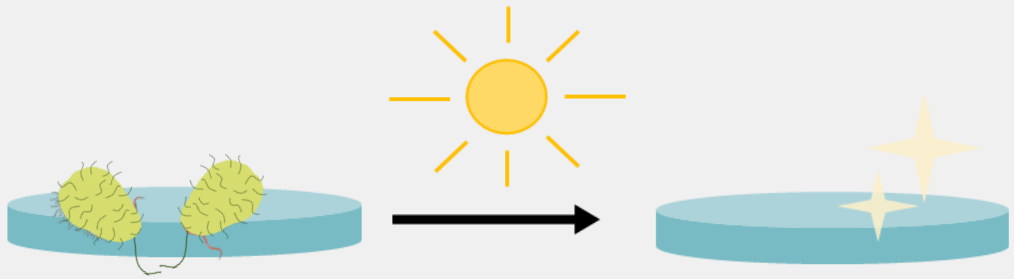


Antibacterial properties

Alizarin epox- **Eugenol mono** + **di-epoxydized** **50/50**

Tg = 65.14 °C

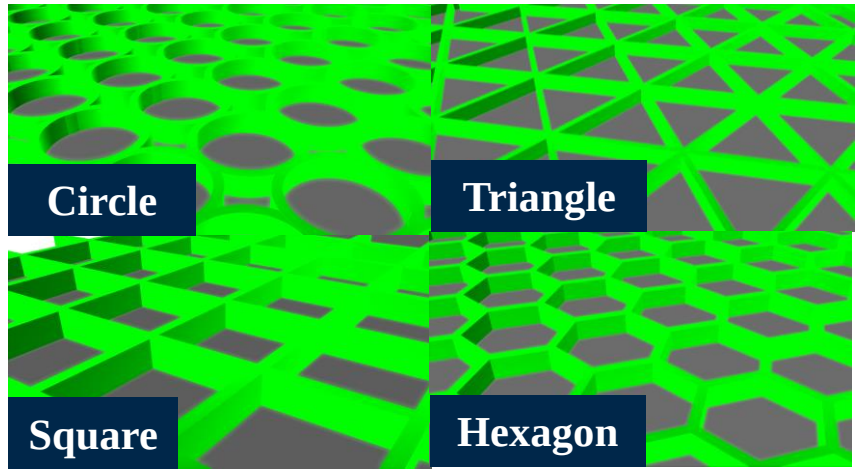


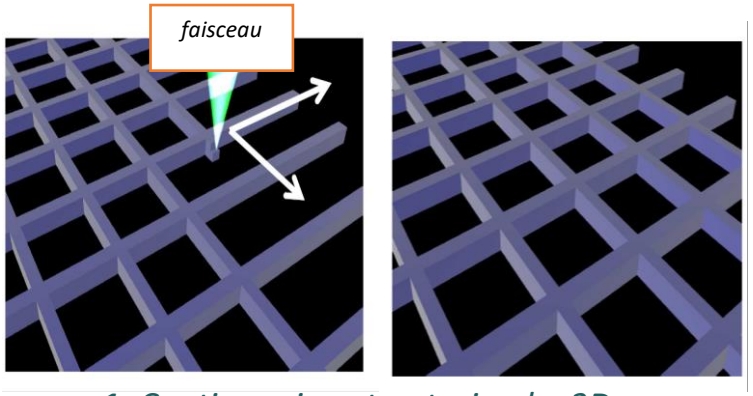


Perspectives:

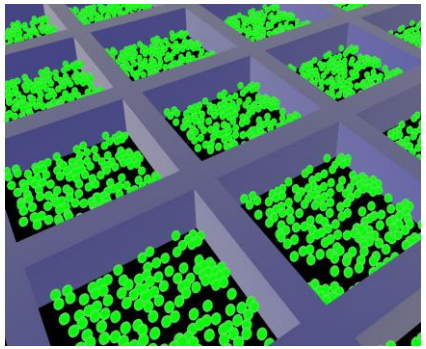
→ 3D printing:
Surface microstructuring

with different pore shapes

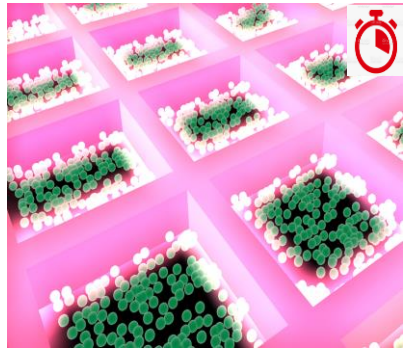




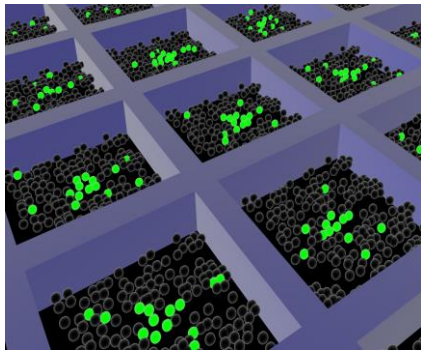
1. *Coating microstructuring by 3D-Printing*



2. *Bacteria trapping*



3. *Visible irradiation: generation of ROS*



4. *Bacterial death*

Acknowledgements

Supervisors:

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Davy-Louis VERSACE – *ICMPE*

Samir ABBAD ANDALOUSSI – *LEESU*

ICMPE – C3M department – *BioM&M's*
LEESU laboratory
ICGM laboratory

Thank you for your attention

Synthesis of innovative and bio-based materials for bacterial depollution

Christine Elian

Régis MOILLERON
Davy-Louis VERSACE
Samir ABBAD ANDALOUSSI

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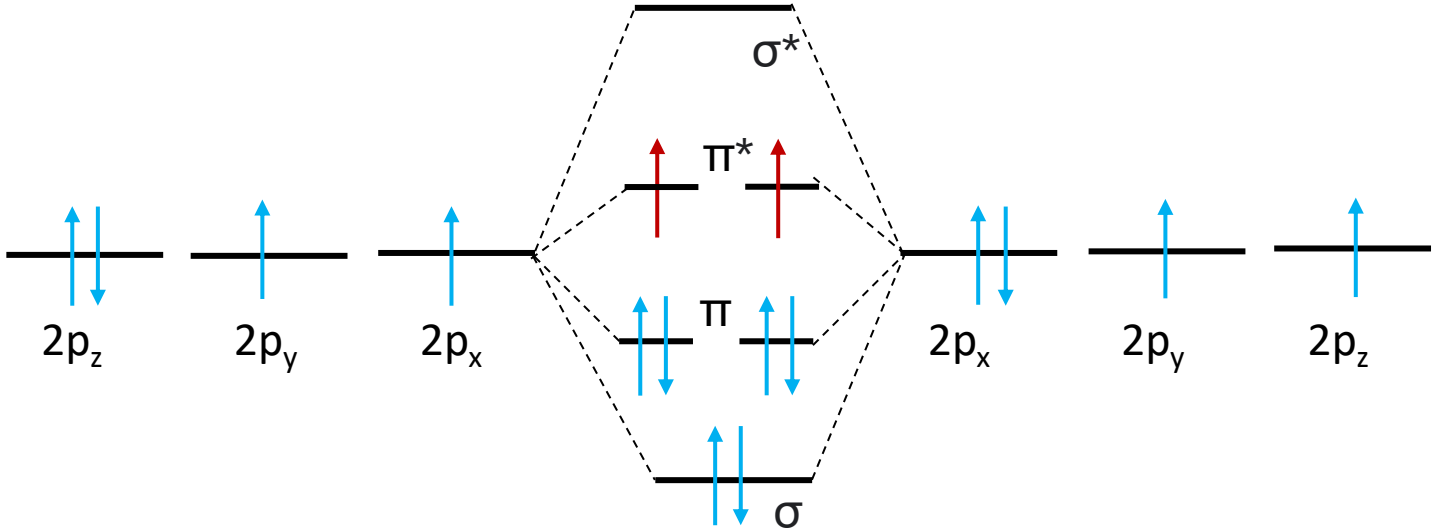
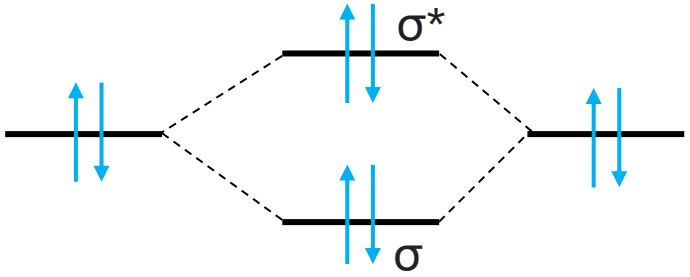
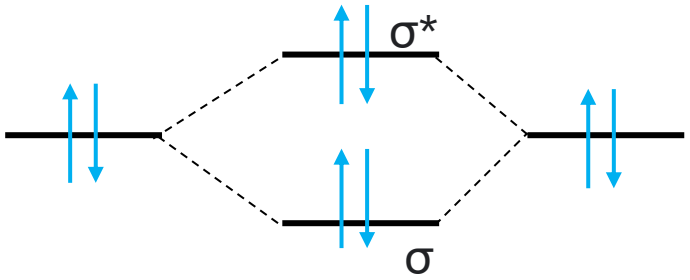
PARIS EST SUP ÉCOLE DOCTORALE Sciences, Ingénierie et Environnement

UPEC UNIVERSITÉ PARIS-EST CRÉTEIL — 50 ANS 1970 ◆ 2020

Signlet oxygen $^1O_2$

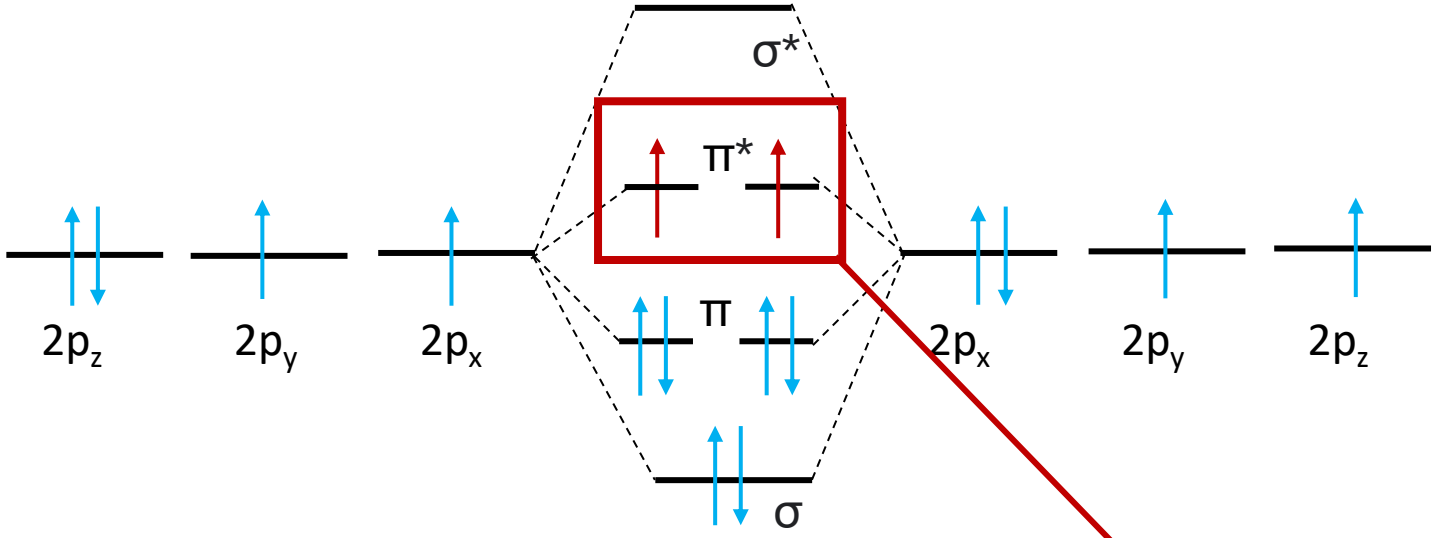


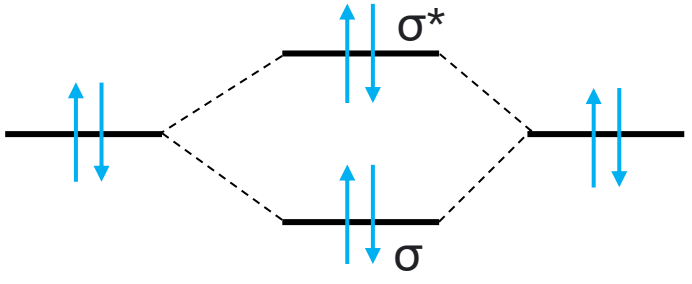


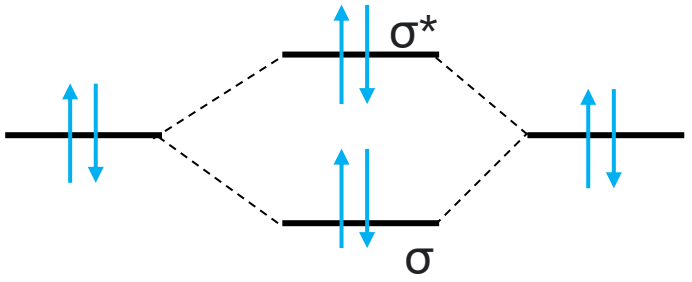


O $^3O_2$ O

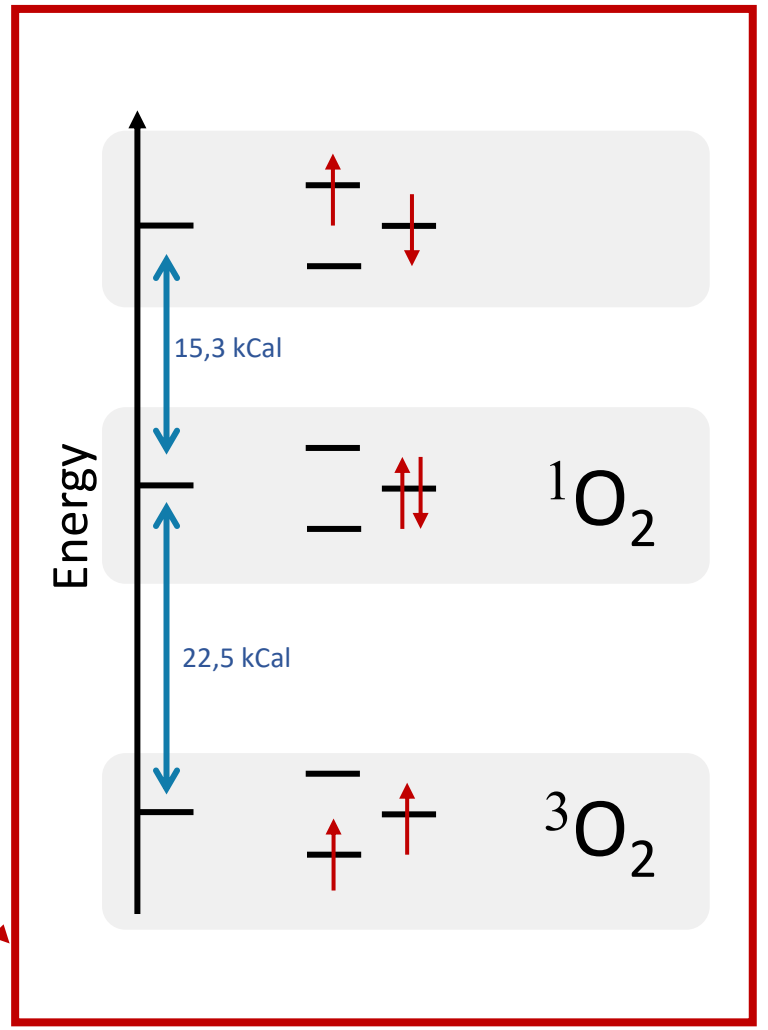
Signlet oxygen $^1O_2$





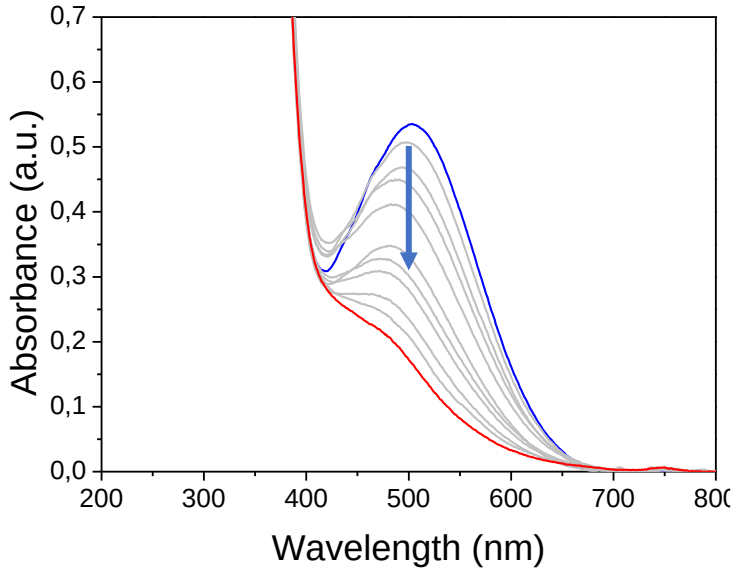


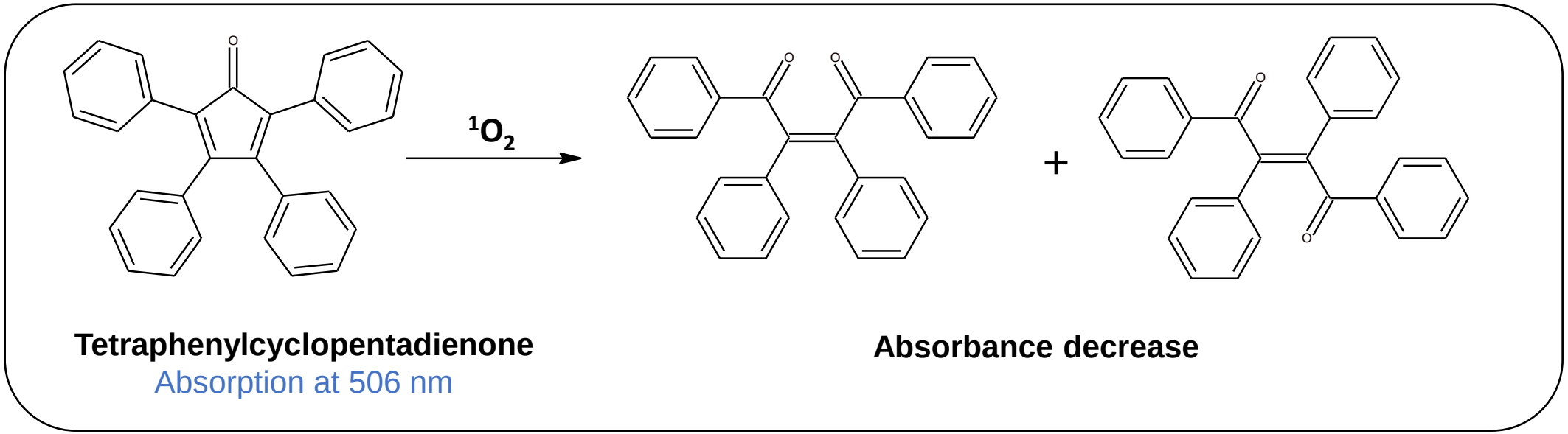
O $^3O_2$ O



Formation of ROS

- ✓ ROS example : singlet oxygen $^1O_2$
- ✓ Demonstration of the presence of $^1O_2$: oxidation



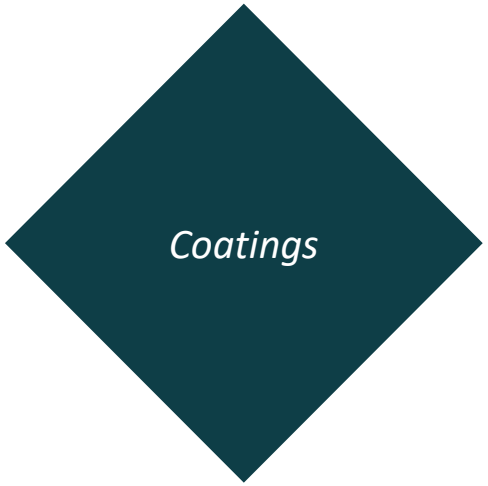


Tetraphenylcyclopentadienone
Absorption at 506 nm

Absorbance decrease

Photochemistry:

Photochemistry:



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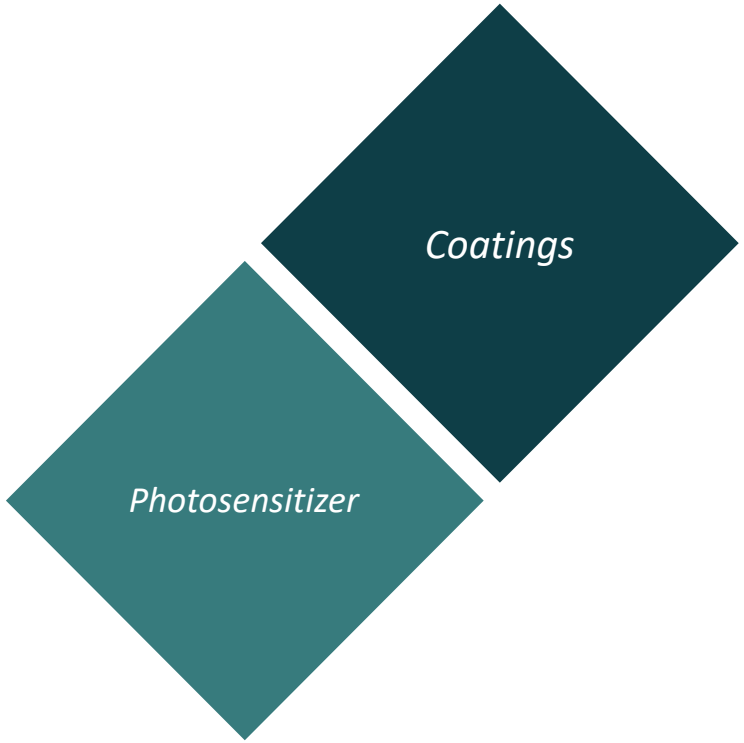

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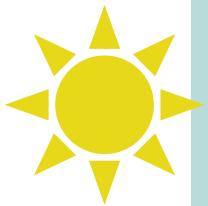
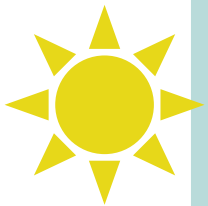


- ✓ Absorption of light energy
- ✓ In the visible range = coloured molecule

Photosensitizer

Coatings

Photochemistry:



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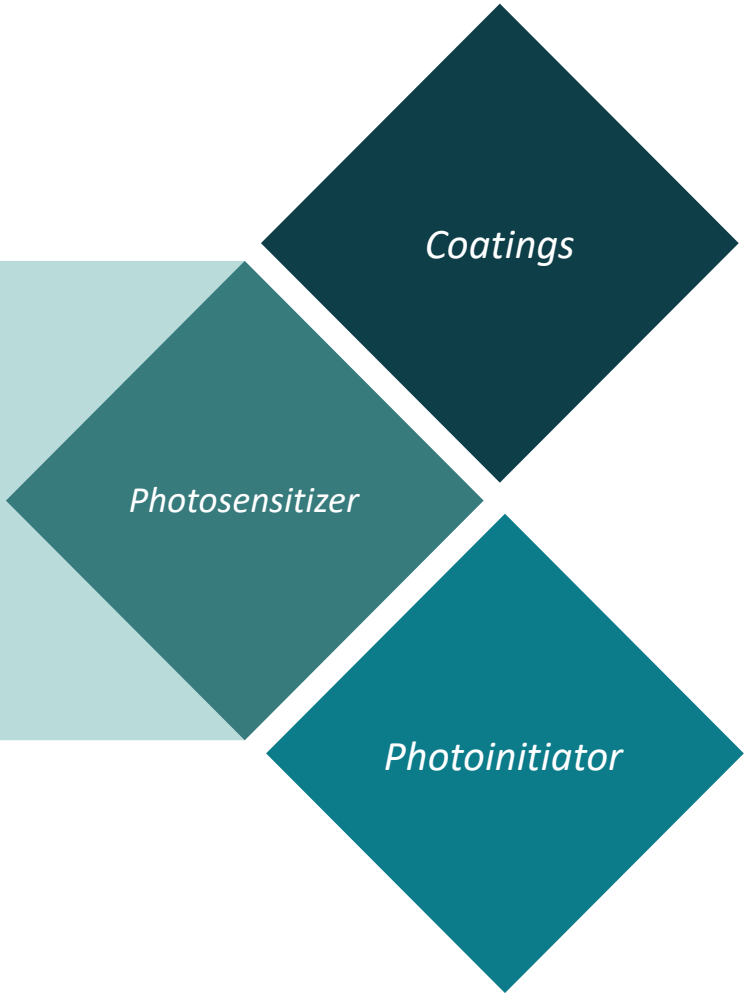
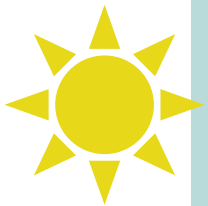


Photochemistry:



- ✓ Absorption of light energy
- ✓ In the visible range = coloured molecule

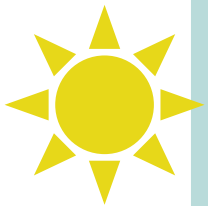
Coatings

Photosensitizer

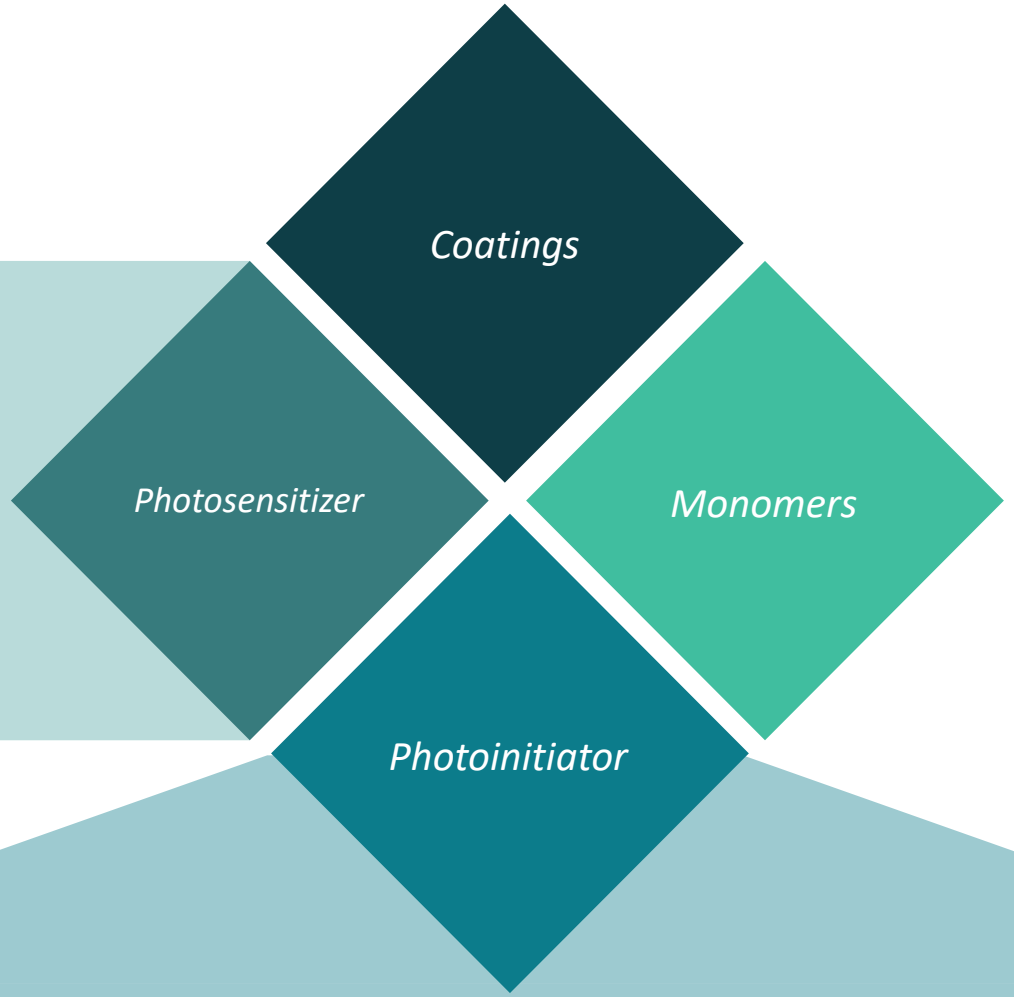
Photoinitiator

- ✓ In the visible range: not able to initiate polymerization → need a dye

Photochemistry:

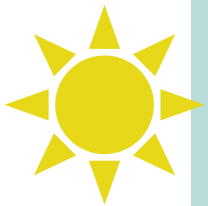


- ✓ Absorption of light energy
- ✓ In the visible range = coloured molecule



- ✓ In the visible range: not able to initiate polymerization → need a dye

Photochemistry:



- ✓ Absorption of light energy
- ✓ In the visible range = coloured molecule

Coatings

Photosensitizer

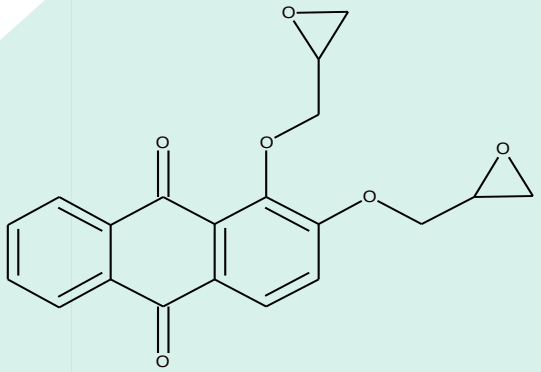
Monomers

Photoinitiator

- ✓ Molecule with reactive functions
- ✓ Able to form networks

- ✓ In the visible range: not able to initiate polymerization → need a dye

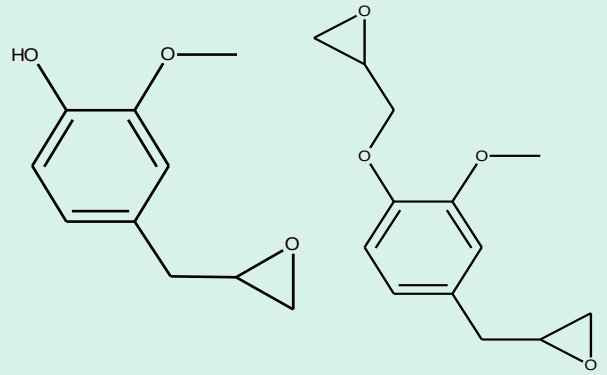
Photosensitizer



Alizarin epoxidized

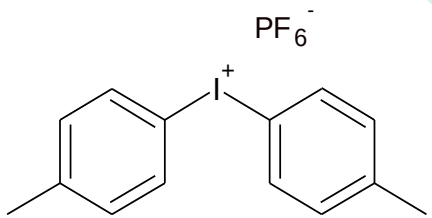
+

Monomers



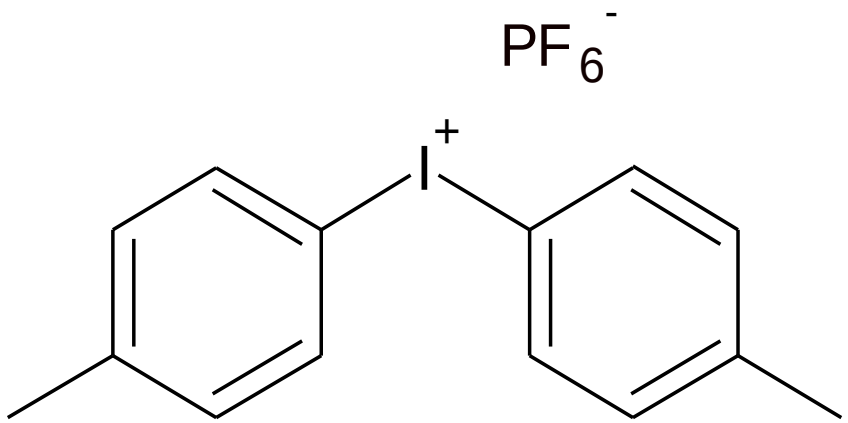
Eugenol mono- and di- epoxidized

+ Photoinitiator



Antibactarial materials

Co-initiator

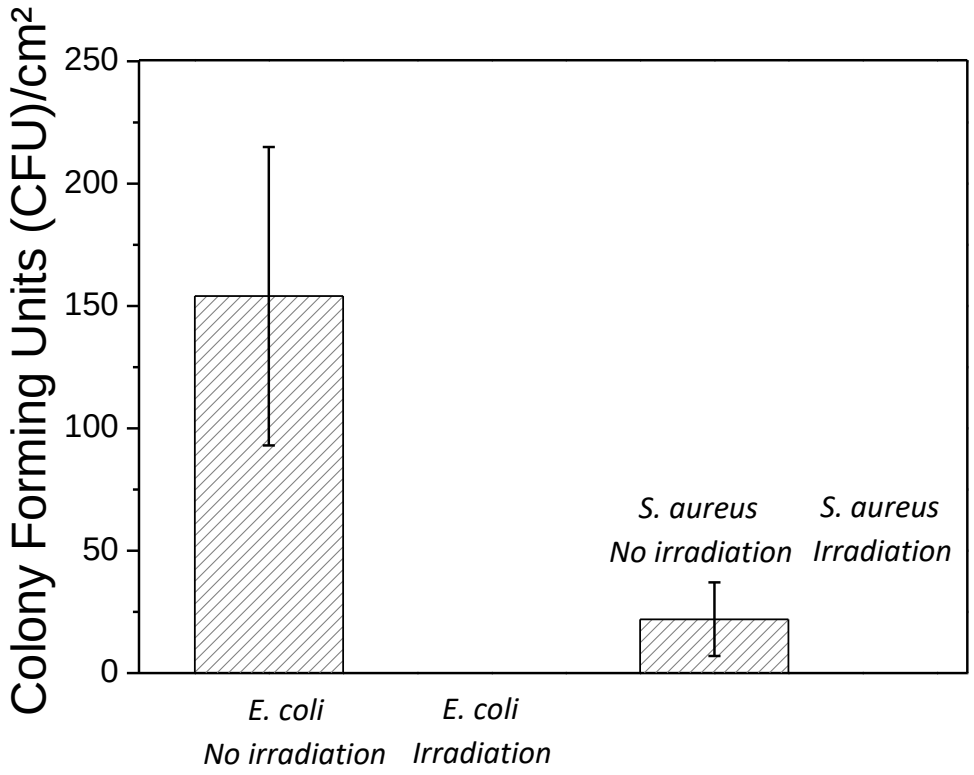


bis(4-methylphenyl)iodonium
hexafluoro-phosphate

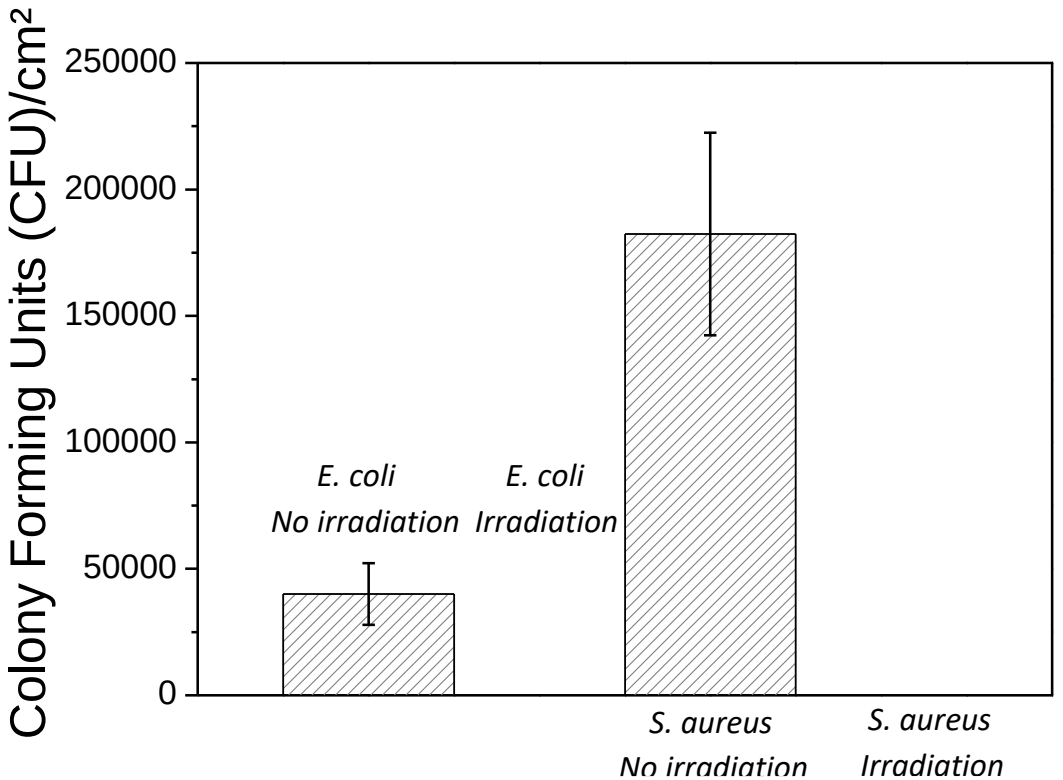
Iod

Antibacterial properties

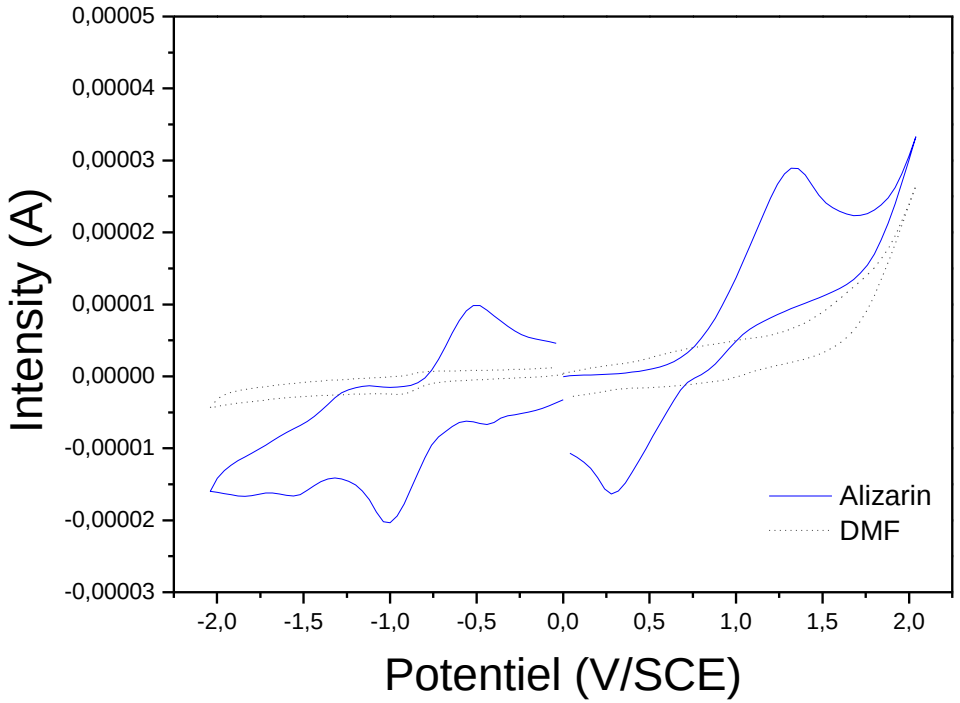
AE-Iod-Eugenol mono di 50/50



AE-Iod-Eugenol di 100

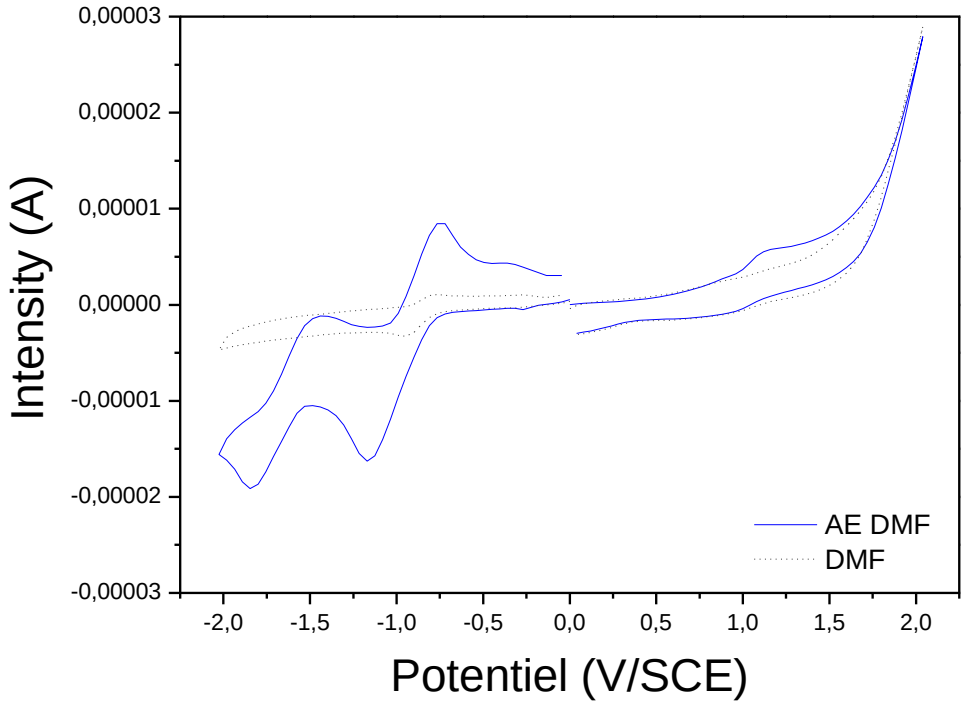


Voltamperometry cyclic



Alizarin

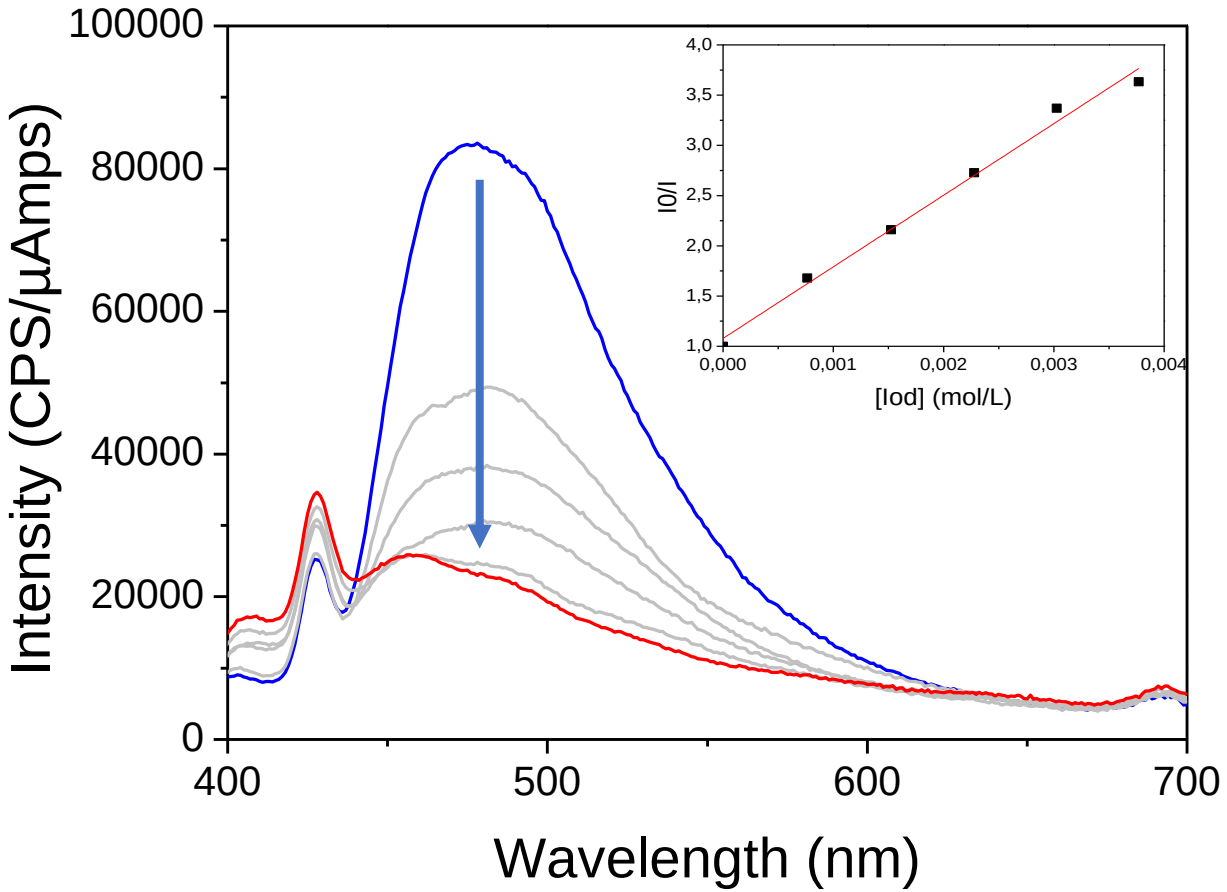
E_{red} = -1.559 V/ESC
E_{ox}= 1.319 V/ESC



Alizarin di- epoxidized

E_{red} = -1.845 V/ESC
E_{ox}= 1.159 V/ESC

Fluorescence



λ_{em} = 481 nm

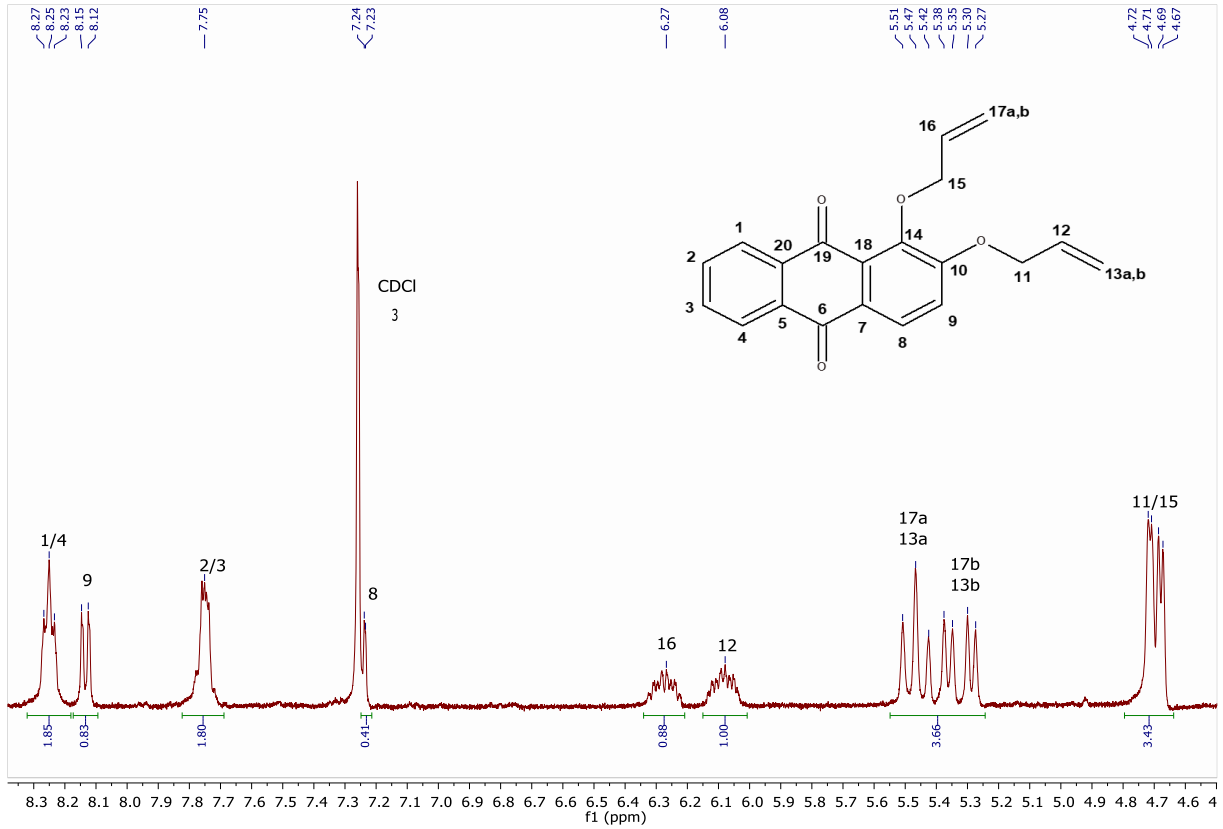
E_s= 2,58 eV

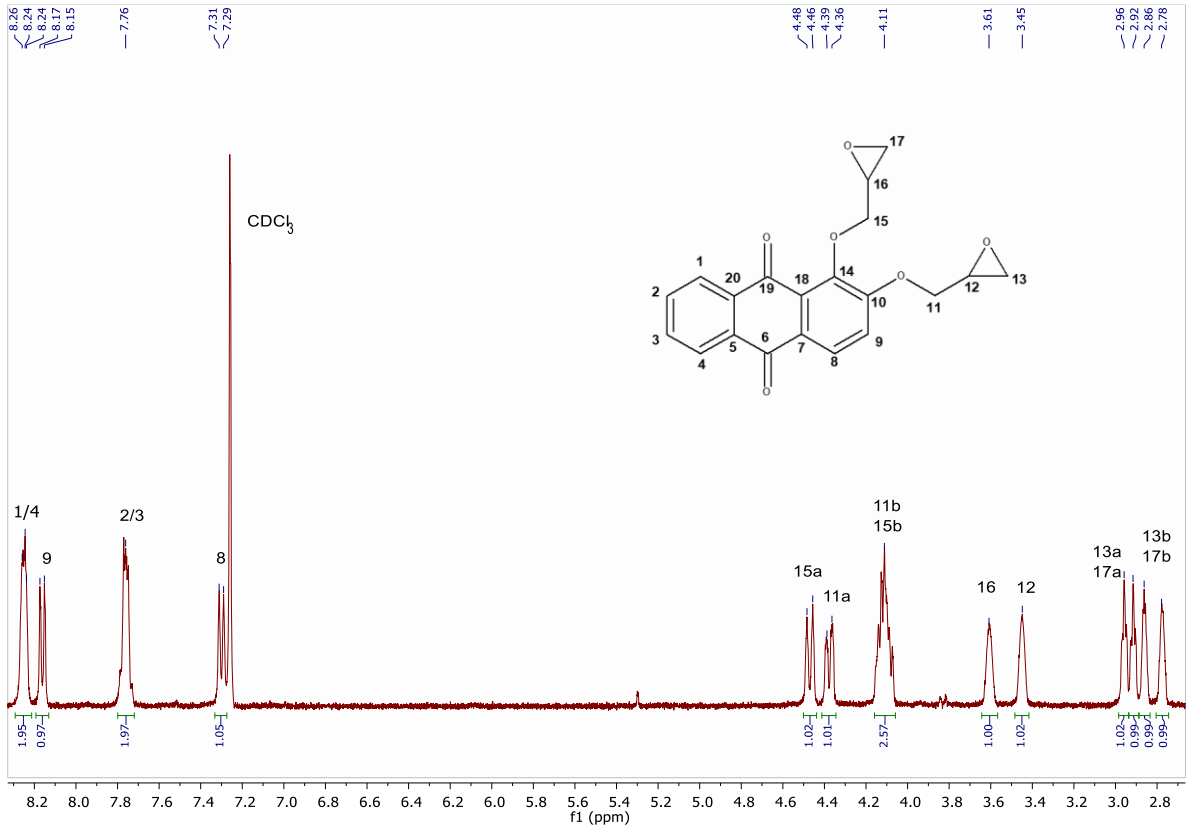
$\Delta G = (E_{ox}-E_{red}) - E_s$ (ou E_T)

With $E_{Iod} = E_{red}$ = -0.2 V

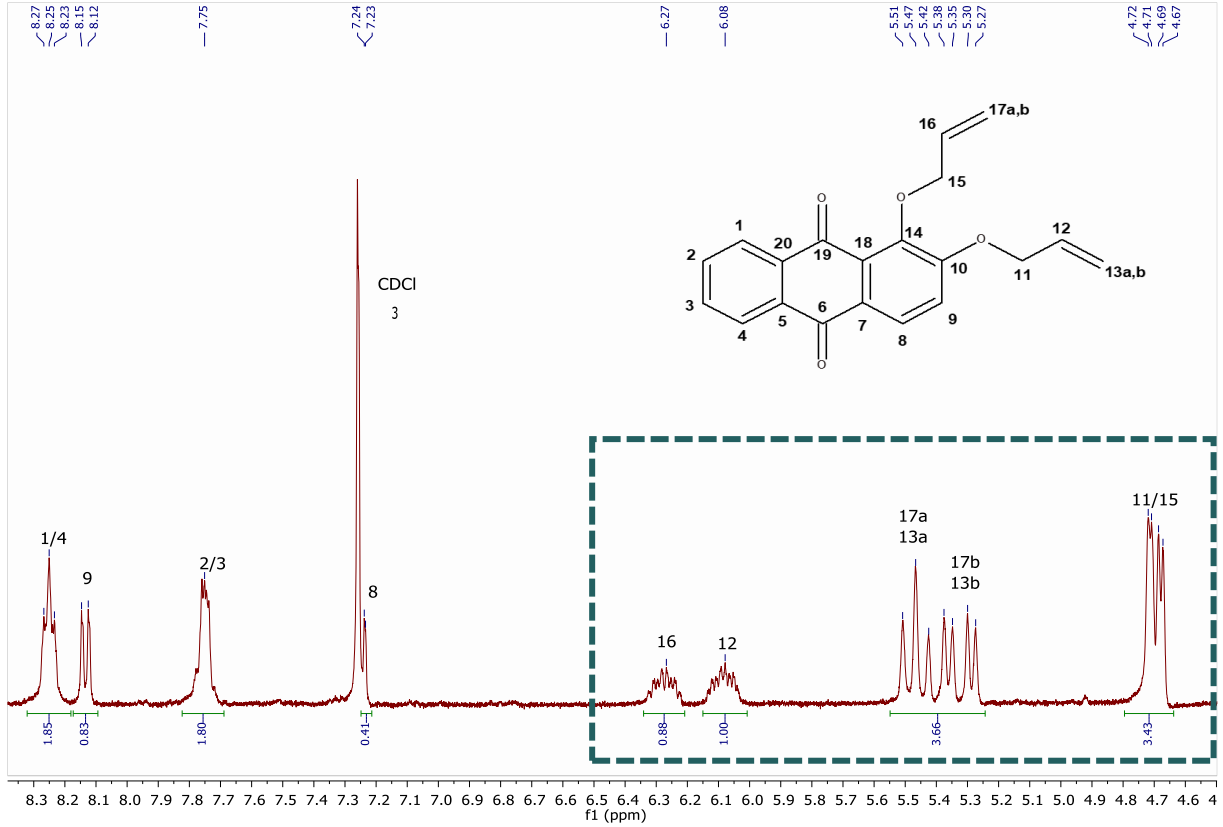
ΔG = -1.22 < 0

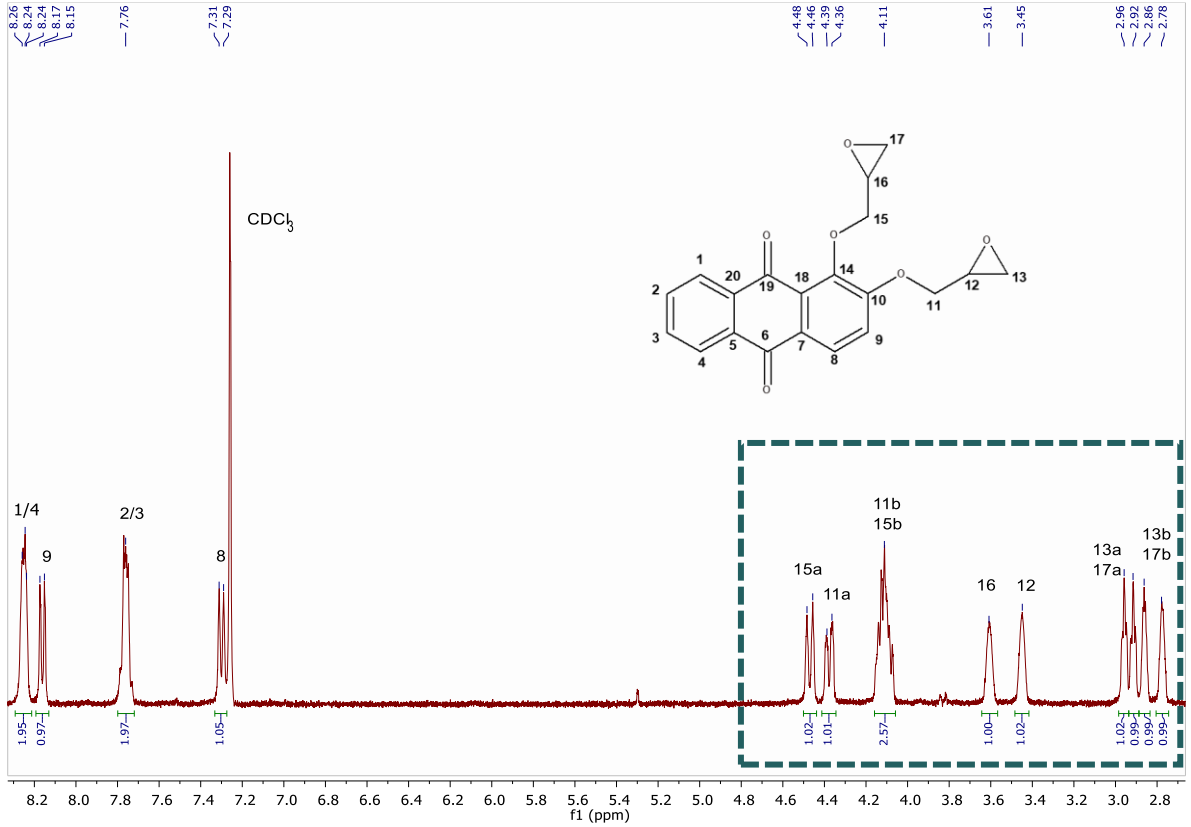
NMR characterization



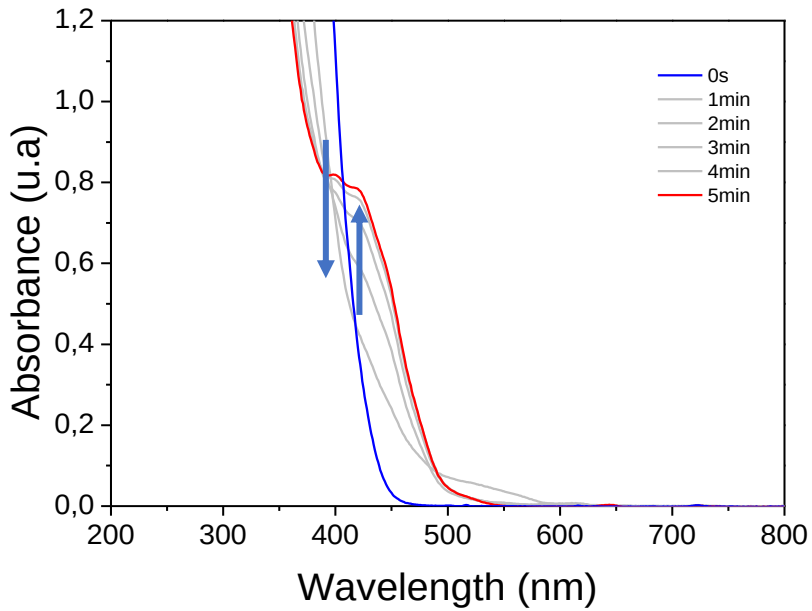


NMR characterization

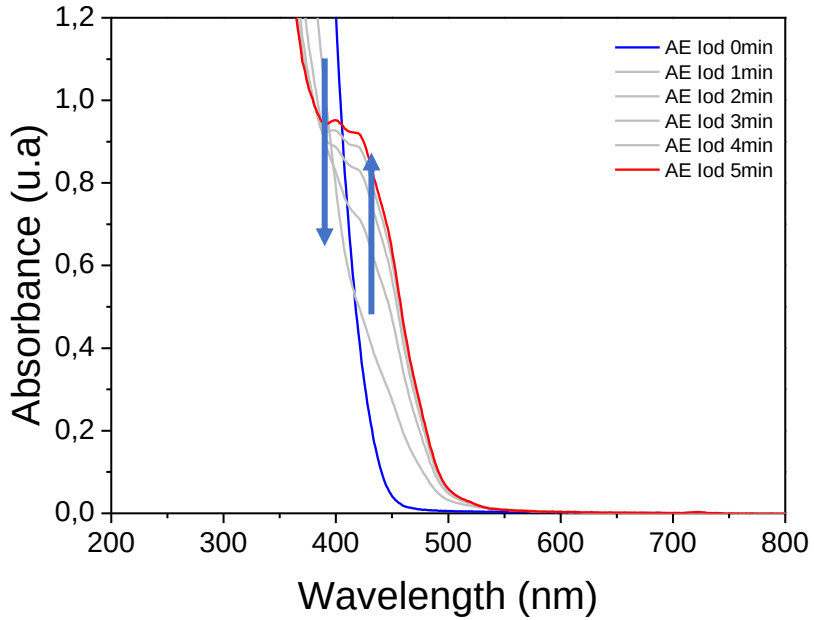




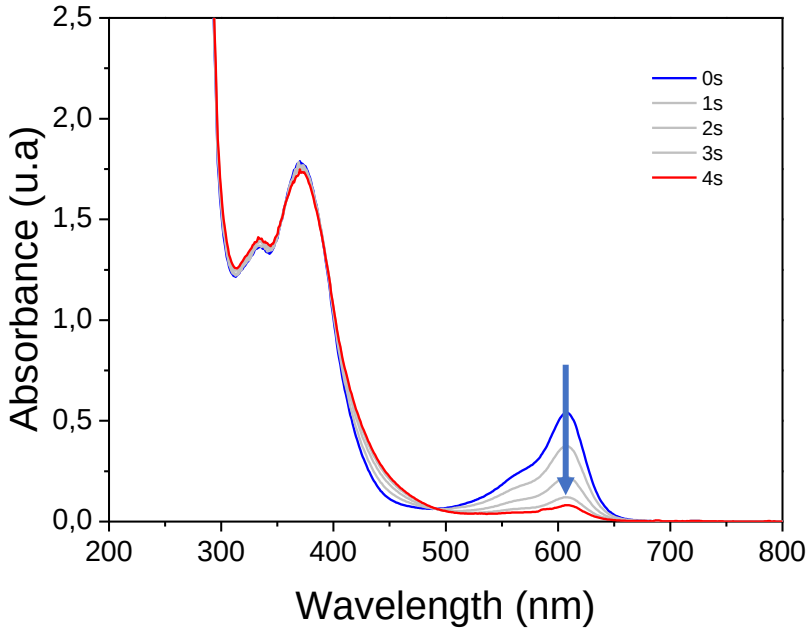
Photolysis



AE



AE-Iod



AE-Iod-Bromophenol blue