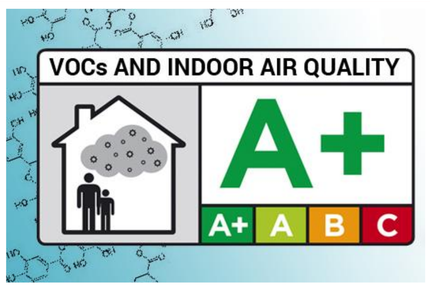
BIOACTIVE COATINGS APPLIED FOR INDOOR AIR QUALITY IMPROVEMENT

Castro C.C.[1], Senechal T.[2], Viseur J.[1], Ducoulembier A.[2], Lahem D.[2], Hantson A.-L.[1]
1 Laboratory of Applied Chemistry and Biochemistry, Faculty of Engineering of UMONS, University of Mons, Mons, Belgium
2 Materia Nova Research and Development Centre, University of Mons, Mons, Belgium

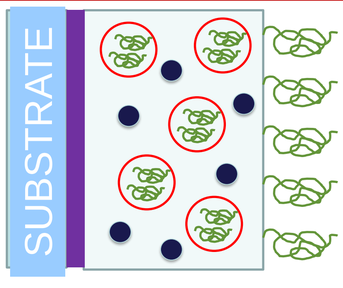
Indoor air pollution of residential units and workplaces is a major concern of nowadays. Toxic pollutants such as formaldehyde, which have carcinogenic effects in health, are constantly released from distinct construction and decoration materials and/or household's products [1,2]. The development of bioactive coatings incorporating biomolecules able to capture and degrade this toxic compound is of major interest. However, the conservation of their bioactivity is crucial throughout time [3]. The incorporation of whole cells in the sol-gel matrix, compared to extracted and purified enzymes, can provide an optimized environment. This allows the conservation of enzymes stability and co-factors regeneration, needed for the enzymatic conversion, besides eliminating extraction/purification costs [4].

The encapsulation of freeze-dried bacterial cells in a sol-gel matrix for formaldehyde degradation is herein studied. Cellulose paper chromatography was used as substrate to immobilize the whole cells, applied by spraying technique. Coated substrates, prepared with different sol-gel formulations, were stored at two different temperatures. Formaldehyde degradation ability and durability of the coatings were evaluated throughout storage time. In addition, coatings surface adhesion, thickness and morphology were also characterized. Results proved that bioactive coatings are a simple, cheap, and environmental friendly technology, efficient to biologically improve de quality of indoor air and even water.

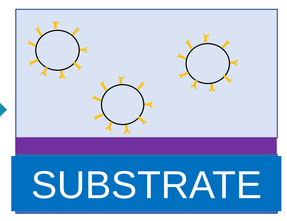
BACKGROUND



Improvement of indoor air quality by VOC degradation



Use of microorganism incorporated in sol-gel coatings



Deposition of the coatings in the surface of substrate

***Pseudomonas putida* ATCC 47054 incorporated in sol-gel coating for formaldehyde decontamination**

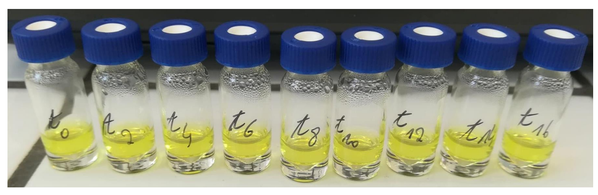
EXPERIMENTAL PLAN

FORMALDEHYDE DEGRADATION EFFICIENCY

- Study of formaldehyde degradation using NASH reagent
- Colorimetric detection of the yellow complex 3,5-diacetyl-1,4-dihydroxydrolutidine (DDL) at 412 nm

COATINGS DURABILITY

- 1 to 5 weeks storage
- Storage temperature:
  Ambient (20 ± 2°C); 37°C



COATING PREPARATION

MICROORGANISM PREPARATION

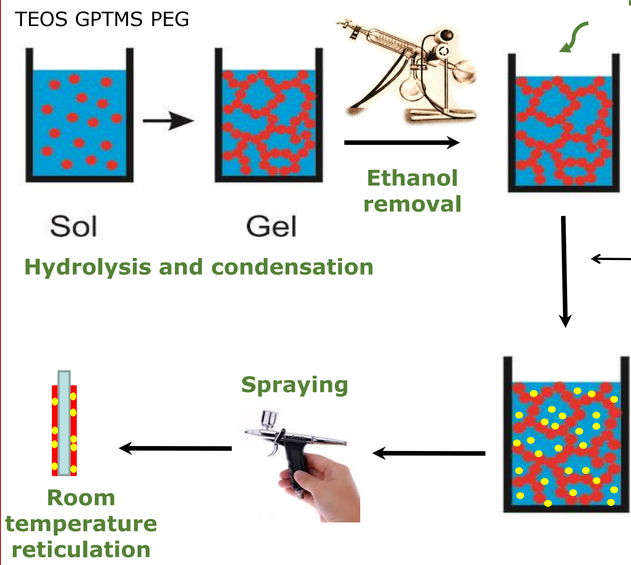
***Pseudomonas putida* ATCC 47054**

Freeze drying

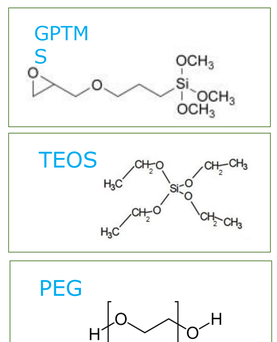
Freeze drying allow to obtain water dispersible particles

Microorganism is biologically inactivated but enzymes activity is recovered after re-hydration

BIO-ACTIVE COATING PREPARATION



Sol-gel precursors



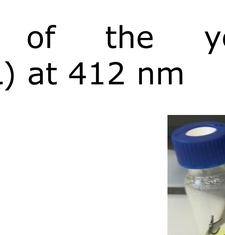
Enzymes are sensitive to :

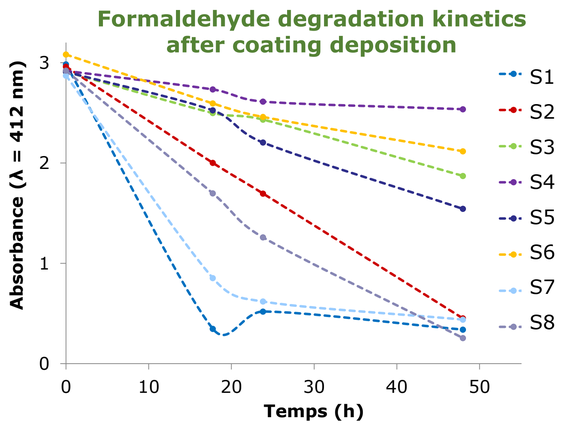
- Temperature
- pH
- Solvents
- UV and ultrasounds

RESULTS AND DISCUSSION

OPTIMIZED EXPERIMENTAL DESIGN

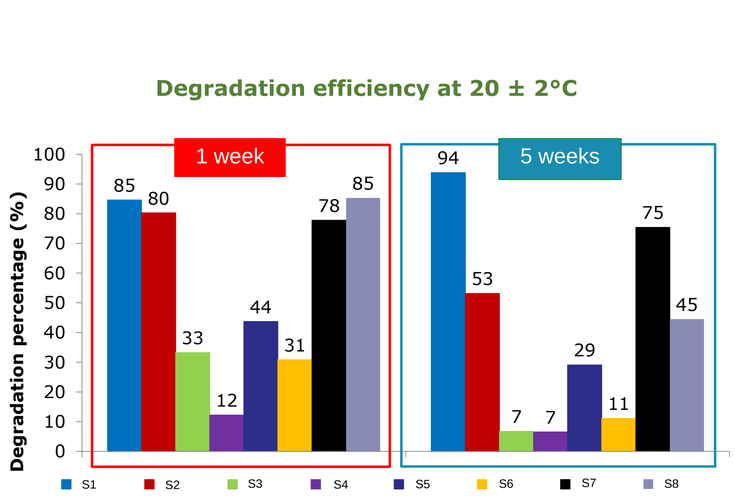
	Sol-gel	PEG (g)	Conc µorganismes (%)
S1	90-3	8	40
S2	90-3	0	40
S3	90-1	8	30
S4	90-1	0	30
S5	90-3	0	30
S6	90-1	0	40
S7	90-3	8	30
S8	90-1	8	40

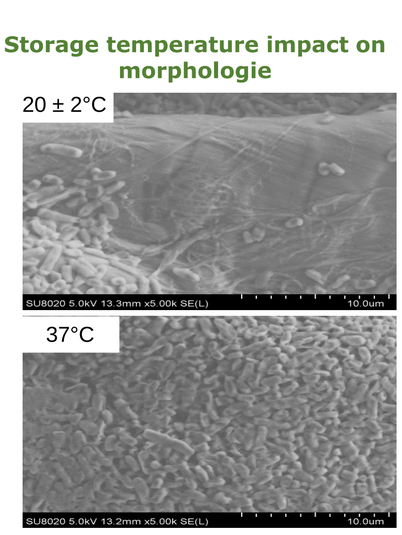




- Cells incorporation allows enzymatic degradation of formaldehyde
- The presence of PEG improved formaldehyde degradation by bio-coatings
- Formaldehyde degradation was complete after 24 h in series 1 and 7

EVALUATION OF COATINGS DURABILITY





- After 5 weeks storage at 20 ± 2°C, series 1 and 7 maintain the degradation efficiency
- Cells dehydration at 37°C decrease formaldehyde degradation efficiency

CONCLUSIONS

- ❑ Cells immobilization in sol-gel coatings allows enzymatic degradation of formaldehyde (no diffusional limitations)
- ❑ The presence of PEG provides humidity to improve enzymatic activity for formaldehyde degradation
- ❑ Formaldehyde degradation is efficient after 5 weeks storage
- ❑ Storage temperature interferes with formaldehyde degradation efficiency

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