VRIJE UNIVERSITEIT BRUSSEL

The faculty of Engineering of the Vrije Universiteit Brussel invites you to attend the public defense leading to the degree of

DOCTOR OF ENGINEERING SCIENCES

of **Benjamin Claessens**

The public defense will take place on **Monday, 11th January 2021 at 5pm.**

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ENHANCING BIOBUTANOL RECOVERY VIA ADSORPTION: ADSORBENTS, 3D-PRINTED MONOLITHS AND UNEXPECTED EQUILIBRIUM EFFECTS

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Abstract of the PhD research

Environmental concerns, rising global temperatures and decreasing availability of oil and gas are pushing society and chemical industry to find alternatives for fossil-based chemicals. In this perspective, the use of renewable, waste biomass (e.g. food, agricultural waste) as a source for chemicals and materials is gaining ever increasing interest. Two interesting molecules which can serve as a platform to produce chemicals and materials are *n*-butanol and isobutanol. Both molecules are produced on an industrial scale in a fermentation process, similar to the production of alcohol for beverages. However, the final concentration of the produced butanol in the fermentation mixture is very limited (< 2 wt%), making butanol recovery and purification a major challenge. In this thesis, the use of adsorption-based recovery is explored as an alternative to the traditional recovery via distillation.

Adsorptive separations are based on the affinity of molecules for a porous, solid material, which can selectively remove molecules from complex chemical mixtures. A crucial aspect is the selectivity of the adsorbent, e.g. its ability to discriminate between different mixture components. In a first part of the thesis, selective adsorbents were identified to remove isobutanol from liquid fermentation mixtures or from gasses which are produced during the fermentation. In a second part, the use of 3D printing to manufacture structured adsorbents was explored. The use of these printed ZIF-8 structures to recover *n*-butanol from model fermentation gas mixtures was studied, showing the importance of monolith design in allowing a good gas distribution in the structured adsorbent. Finally, the fundamental mechanism of adsorption in ZIF-8 was explored more fundamentally, showing the importance of interactions between molecules. Overall, this PhD has led to the identification of promising adsorbents for biobutanol recovery and the exciting possibilities of 3D-printing to manufacture structured adsorbents were explored.