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 **Ravi Sharma**

The public defense will take place on **Friday 10th March 2023 at 4:00pm** in room **D.0.08** (Building **D**, VUB Main Campus)

To join the digital defense, please click here
Meeting ID: 375 921 658 92
Passcode: L34eLr

MOF BASED STRUCTURED ADSORBENTS FOR FLUID PHASE SEPERATION

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Abstract of the PhD research

From kitchen sieves and strainers to cat litters, porous materials present numerous applications as sorbents, filters, membranes, and catalysts. Traditionally, in adsorptive separation processes these materials are configured in packed beds where high pressure drop and inefficient mass and heat transfer usually incurred due to the random and tortuous nature of the packing arrangement. To overcome these difficulties, use of structured configurations such as monoliths, laminates, honeycombs, have been proposed in the literature. These geometries provide improvement in the targeted system parameters such as lower pressure drop, faster cycle times and lower energy consumption, thus allowing intensification of adsorptive separation processes. Classically, to shape engineer adsorbents such as metal-organic frameworks (MOFs), various routes such as extrusion, casting, foaming, are available. However, apart from the requirement of proper selection of additives to obtain suitable rheological properties without significant reduction in the surface area, these methods are energy intensive and limited in freedom towards material design.

Therefore, development of alternative designs based on metallic and non-metallic support containing channels coated with adsorbents such as metal-organic frameworks (MOFs) for fluid phase separation applications has been proposed. MOFs are microporous crystalline materials which can be synthesized for tailored based applications in the field of separation, purification, and catalysis. In this thesis, taking advantage of their application-oriented feature, different MOFs were synthesized, and shape engineered into structural architectures via in-situ direct MOF growth and ex-situ MOF deposition techniques. Following these techniques, three structured composites were developed: a) ZIF-8 coated copper substrate (laminate, foam) obtained via in-situ direct route for thermal and electrical swing adsorption, b) melamine sponge-based MOF-74 composite fabricated following ex-situ deposition technique for thermal swing adsorption, and c) alginatebased MOF-808 composite pellets functionalised with Fe3O4 for induction-based adsorption processes. Additionally, these structured adsorbents were tested for different separations including PFOS removal from aqueous solutions when present in ppb level, biogas upgrading and water harvesting from air. Overall, this PhD research revealed environment-friendly and promising synthesis routes to develop MOF based structured adsorbents and explored exciting possibilities of applications for the chemical process industry.