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Combined CO_2 capture and photoconversion using bifunctional porous materials

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The sustainable production of energy is an exciting and bustling research area. A key requirement for any new or improved energy production process is the low or nil emission of CO_2. When considering existing energy production routes (*i.e.* power plants), various technologies are available that allow the capture of CO_2 from emitted gaseous streams. Among them, one can cite solid adsorbents that are capable of low temperature CO_2 capture. Metal-organic frameworks (MOFs) represent a class of such adsorbents. Composed of metallic nodes connected by organic ligands, MOFs exhibit an unparalleled chemical and structural modularity, as well as a high porosity. Interestingly, recent studies point to the potential of MOFs as catalysts for CO_2 photoconversion into useful products (*e.g.* CO and CH_4) [1]. Photocatalytic CO_2 reduction requires materials able to utilise energy from absorbed photons to catalytically convert CO_2 into other chemicals. Common CO_2 reduction photocatalysts are semiconductors, the benchmark being TiO_2. Other notable photocatalysts include carbon nitride nanosheets (CNNS) which, like MOFs, can harness solar irradiation and adsorb CO_2.

In our group, we develop bifunctional absorbent-photocatalyst materials for the combined capture and conversion of CO_2 (Fig. 1) This approach could enable intensification of the overall Carbon Capture Utilisation and Storage process. Indeed, in this approach, the energy provided to regenerate the adsorbent can be harnessed for the conversion CO_2 into higher value chemicals.

In this presentation we will discuss our recent work on MOF-based [2] and CNNS-based TiO_2 composites for CO_2 capture and conversion. The structural, chemical and optoelectronic properties of these were fully characterised. The materials were then tested for CO_2 capture and photoreduction using a gas-solid reactor set-up. A key focus of this work was the optimization of the structure and morphology of the composites to enhance CO_2 photoreduction. Optoelectronic analyses, and particularly transient absorption spectroscopy, were conducted to identify the catalytic pathways. This in-depth investigation allowed us to identify specific material design strategies to enhance the performance of such bifunctional materials and explain the enhanced performance of our composites with respect to TiO_2.

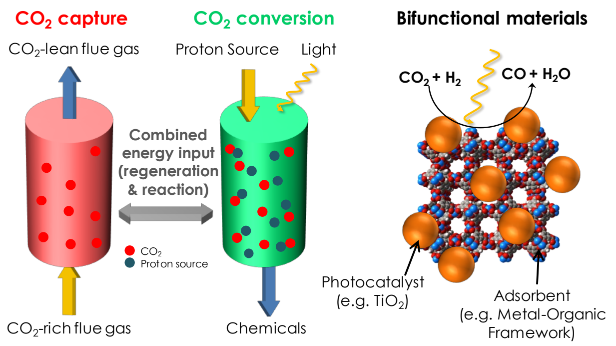

Figure 1. Schematic of a combined CO_2 capture and photocatalytic conversion process using bifunctional materials

Acknowledgments

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References

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