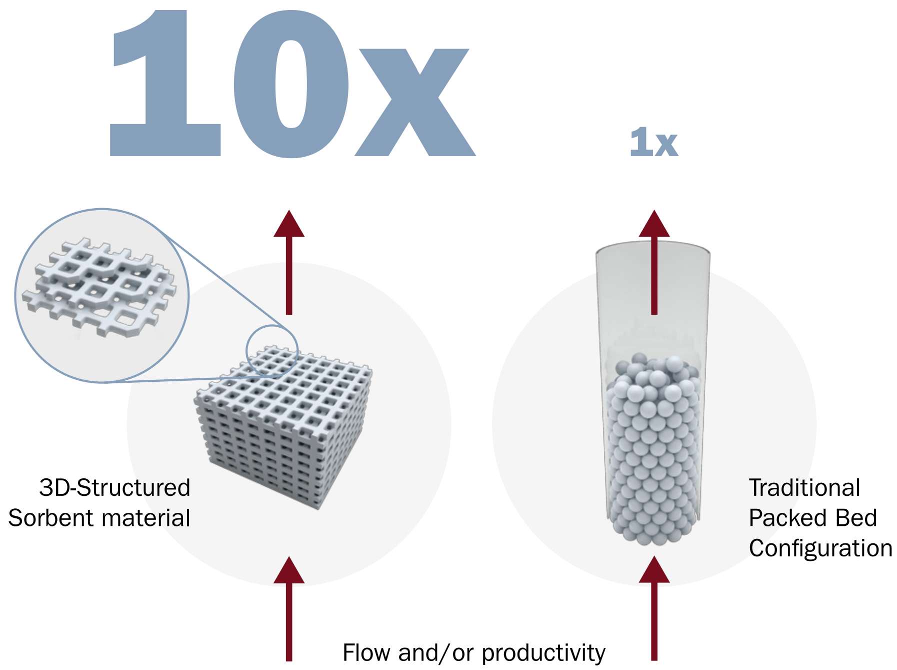
3D-PRINTED CAPTURE MATERIALS FOR PRODUCTIVITY STEP-CHANGE



Reducing the carbon footprint of many of the technologies associated with today's society is a challenge in terms both the size of equipment and the energy associated with the carbon abatement.

The 3D-CAPS project will significantly reduce the size of equipment associated with removing and recovering CO_2 from industrial gases using two promising new adsorption-based technologies with an inherent small energy footprint.

The required adsorbents for these technologies will be prepared using the latest innovations in additive manufacturing (3D-printing). This technology allows to prepare bespoke materials with much improved heat and mass-transfer characteristics, that are not available through traditional material preparation routes.

The project will assess performance of the resulting structured adsorbents with techno-economics within at least two CCS sectors: Natural Gas Combined Cycles electricity production, and decarbonised H_2 production for refinery application. 3D-CAPS will culminate in a proof-of-concept of the new materials, and blueprints for a large scale pilot demonstration where the target is to reduce equipment size by a factor of 10.

This flyer gives an overview of the project.

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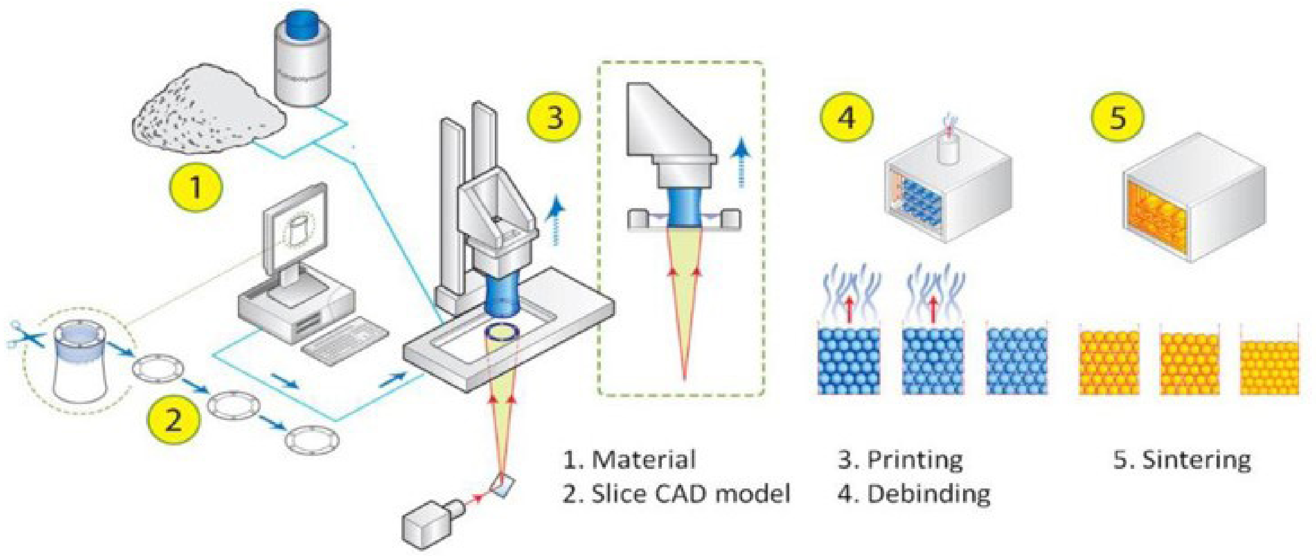


Representation of DLP process. 1: Paste development, 2: slice design, 3. Printing 4. Debinding & 5: Sintering.

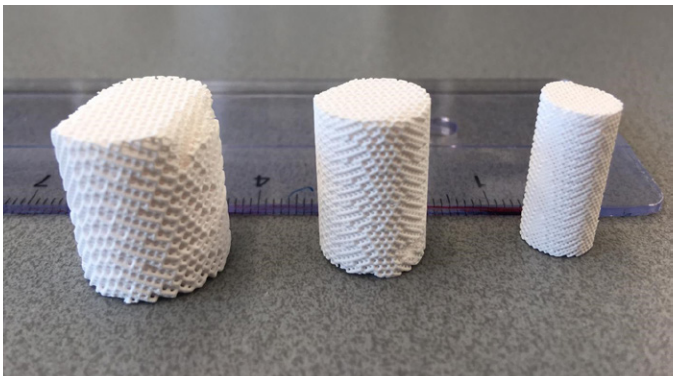
3D-PRINTING

Structured high surface area sorbent materials are prepared with digital light processing (DLP) 3D-printing:

– Amine functionalised silica (ImmoAmmo);
– Hydrotalcite (HTC).

First, pastes for printing -mixtures of the sorbent, UV-sensitive monomer, photo-initiator and additives- are developed. These are then used to print the desired 3D-structures, that have been designed and investigated in the modelling workpackage (WP). After printing, the objects are exposed to a debinding and sintering post- treatment to give them their final form and strength.

For ImmoAmmo, the 3D-printed porous silica structures (designed & investigated in WP3) are functionalised with amines.



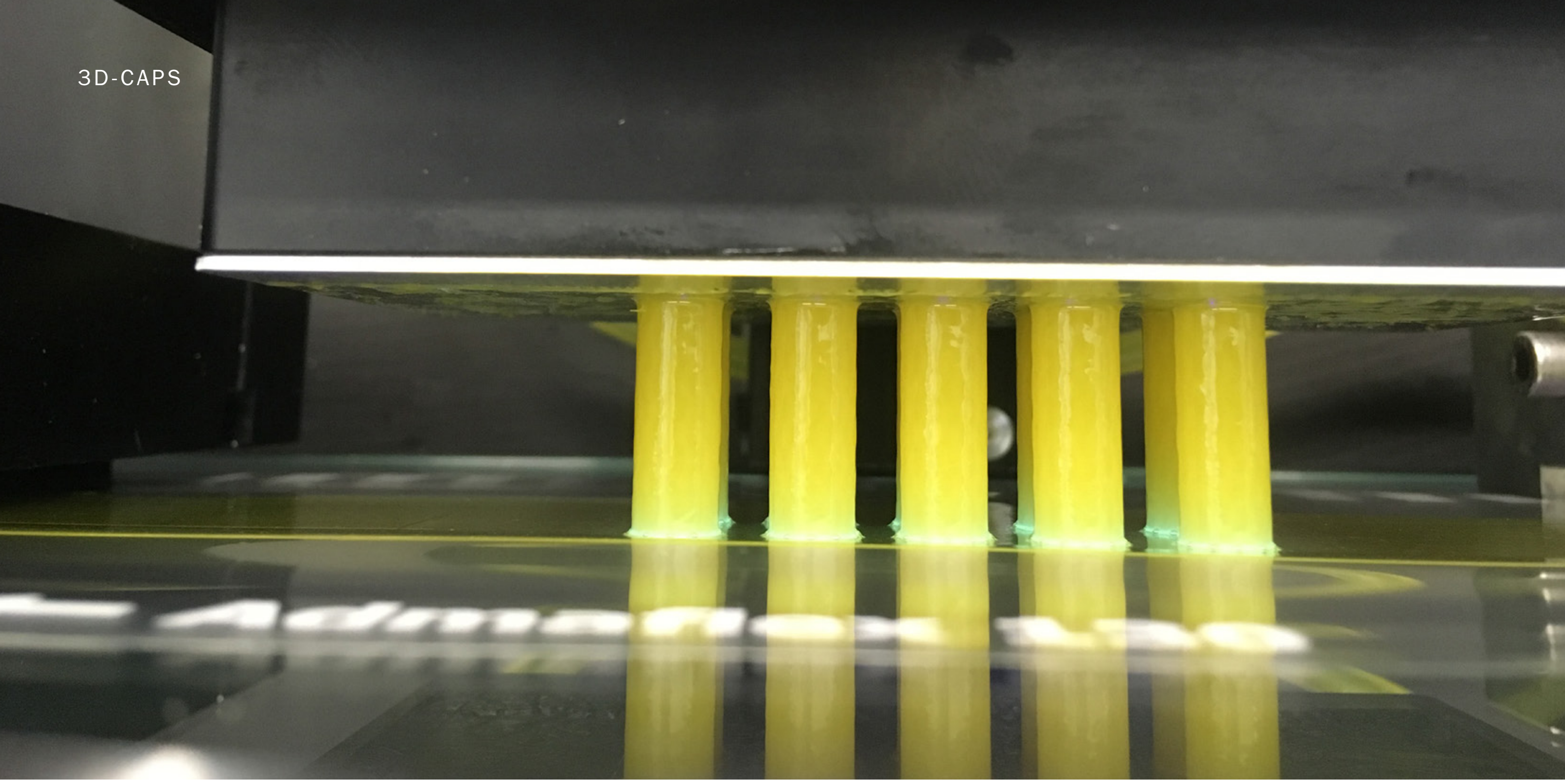
3D-printed isoreticular foams

TESTING

The main objective of this work package is to demonstrate Pressure Swing Adsorption (PSA), Temperature Swing Adsorption (TSA) and vacuum PSA processes utilizing the 3D-printed adsorbents from the printing WP up to TRL5. This will be done by measuring all relevant adsorption characteristics (equilibrium isotherms and kinetic parameters) for the relevant gaseous components (CO_2, N_2, H_2O), and by evaluating the effect of competing adsorption necessary for the process modelling in the modelling work package. The effect of relevant impurities (SO_x, H_2S) and the long-term stability of the sorbents at pro-longed cycling (up to 1000 cycles) will also be studied.

The structured sorbents will be evaluated against traditional pellets.

Reactor with 3D printed structure and test equipment.



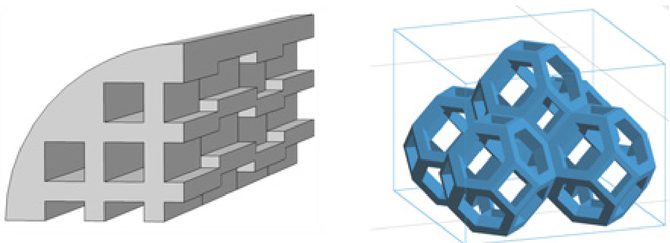
MODELLING

This WP focusses on mathematical modelling and simulation of different channel and mixing concepts for 3D-sorbents, considering kinetic, mass & energy transfer aspects:

1. Computational Fluid Dynamics (CFD) modelling to optimize 3D-printed configurations;
   - Develop CO_2 adsorption through a single monolith channel (with different geometries) using 2D models in COMSOL Multiphysics;
   - Develop & test complex 3D multi-channel models (3 different geometries) by simulation to evaluate the necessary computer resources.

2. Multi-Cycle modelling to study the performance of the sorption cycle with 3D-Sorbents;
   - Simulate the existing multi-cycle model to find the most relevant design parameters of the process using MATLAB.

3. Flow-sheeting to integrate the sorption system;
   - Identify reference & 'business-as-usual' cases for CO_2 capture for the application areas;
   - Process flow-scheme for 3D-variants base-case technologies.



Monolith with zig-zag channels (left; for SEWGS process) and iso-recticular foam (Kelvin cell, right; for ImmoAmmo)

TECHNOLOGY EXPLOITATION

Last but not least, the project focusses on the impact of this new sorbent manufacturing method on applications within multiple CCS projects, and by extension many related sorption- and catalysis-based systems. This will be achieved through:

- Examination of the product-market combination;
- Preparation of market forecast together including client surveys;
- Development of a strategy for supply chain and value propositions;
- Maturation of a business plan and communication strategy;
- Placement of commercial agreements.

The activities in this WP are aimed at improving business models in order to maximize the impact of the expected step-change in activity that this technology can bring to the field.

Please help us by filling in the survey on the site below!

https://3d-caps.eu

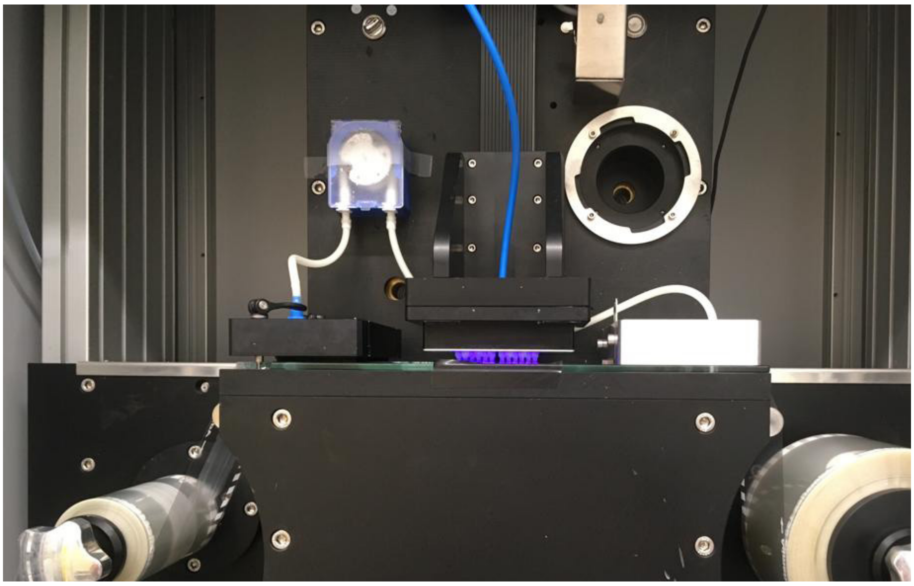
3D CAPS

CONSORTIUM

3D-CAPS brings together a consortium of partners from industry, a SME, research and academic institutes from across Europe in a two year project. The team has the appropriate skill sets and expertise to bring this technology further, e.g.:

- Deep background knowledge in advanced manufacturing technology for producing 3D-structured materials;
- Existing infrastructure to test materials up to the TRL5 level;
- CFD modelling and cycle design capabilities;
- Understanding of factors and network to successfully implement the technology the field.

We are committed to demonstrate a 10-fold CO_2 capture productivity increase by 3D-structuring adsorbents and to explore the exploitation of this technology.



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Accelerating CCS Technologies

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