

Magnetic Framework Composites for Efficient CO₂ Capture & Release

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The Problem



Atmospheric CO₂ increasing – from 280 to over 400 ppm¹



Big impact on society and environment – 250,000 deaths predicted annually²

42%
Electricity and heat

Coal-fired plants
10.1Gt
CO₂ in 2018

Major global contributor is power plants³ – suggests post-combustion carbon capture effective, retrofitted into existing plants

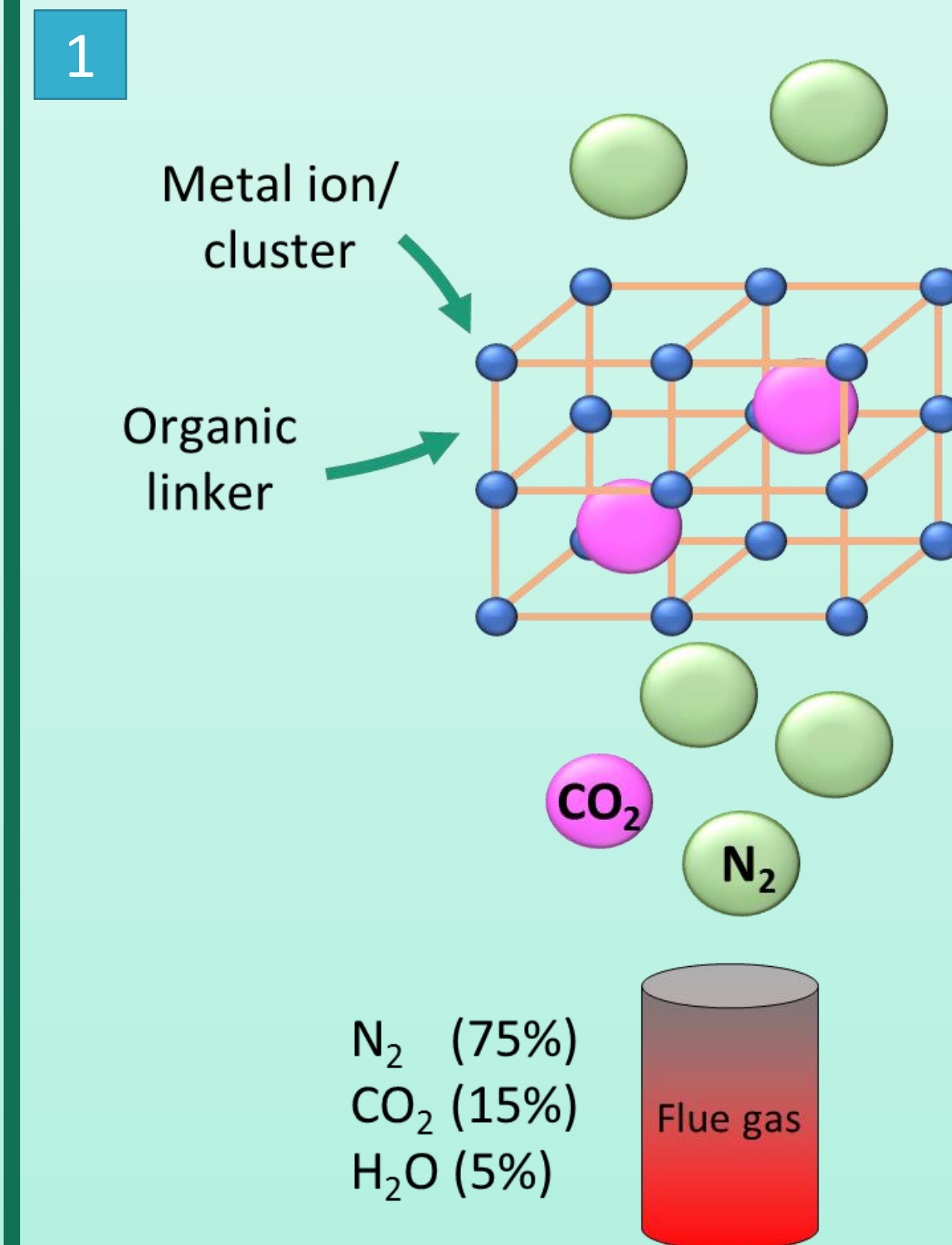


Current capture methods too energy intensive/expensive - increasing a power plant's energy demand by 25-40%⁴

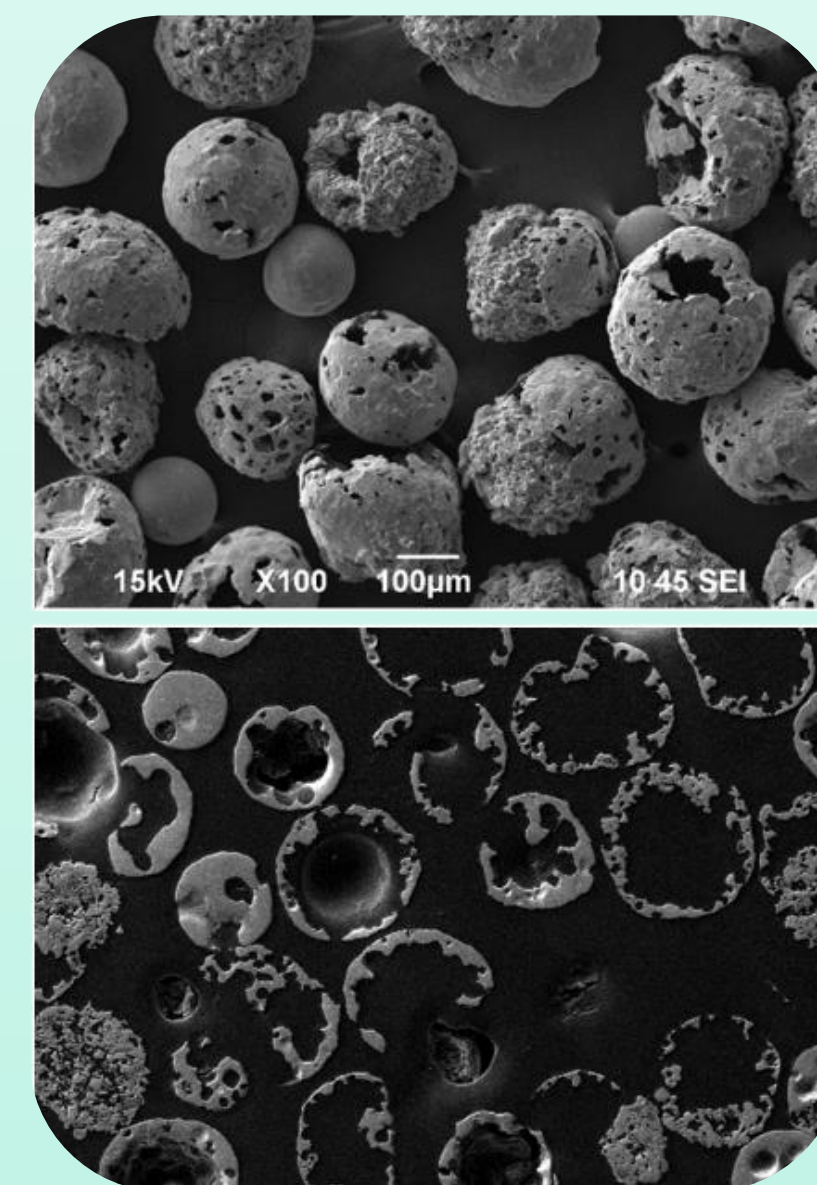
The Solution

1 metal-organic frameworks (MOFs)

MOFs SIFSIX-3-Cu and UTSA-16(Zn) chosen due to high CO₂ capacity, high CO₂/N₂ selectivity and sustainable synthesis^{5,6}

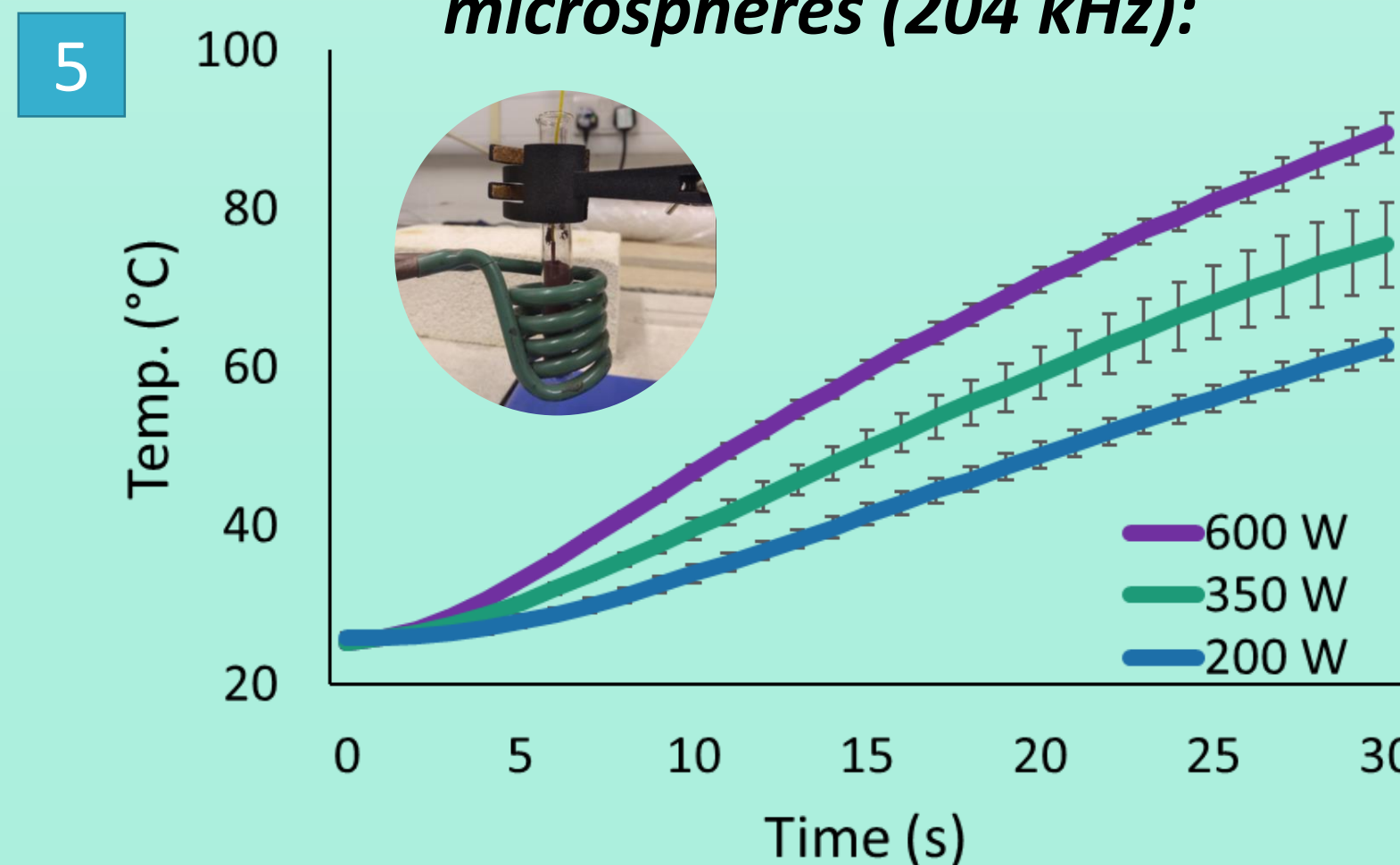


2 magnetic microspheres

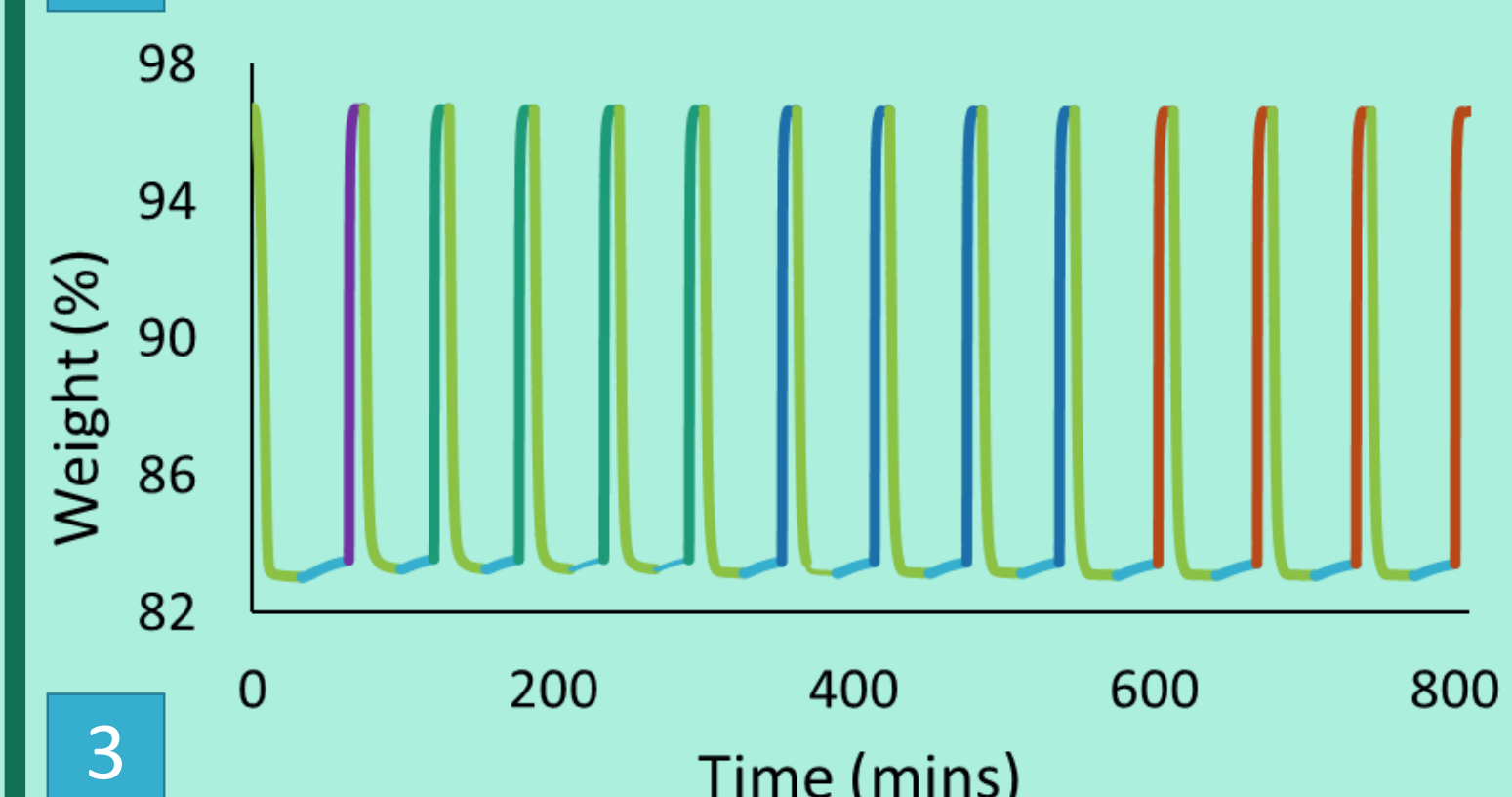
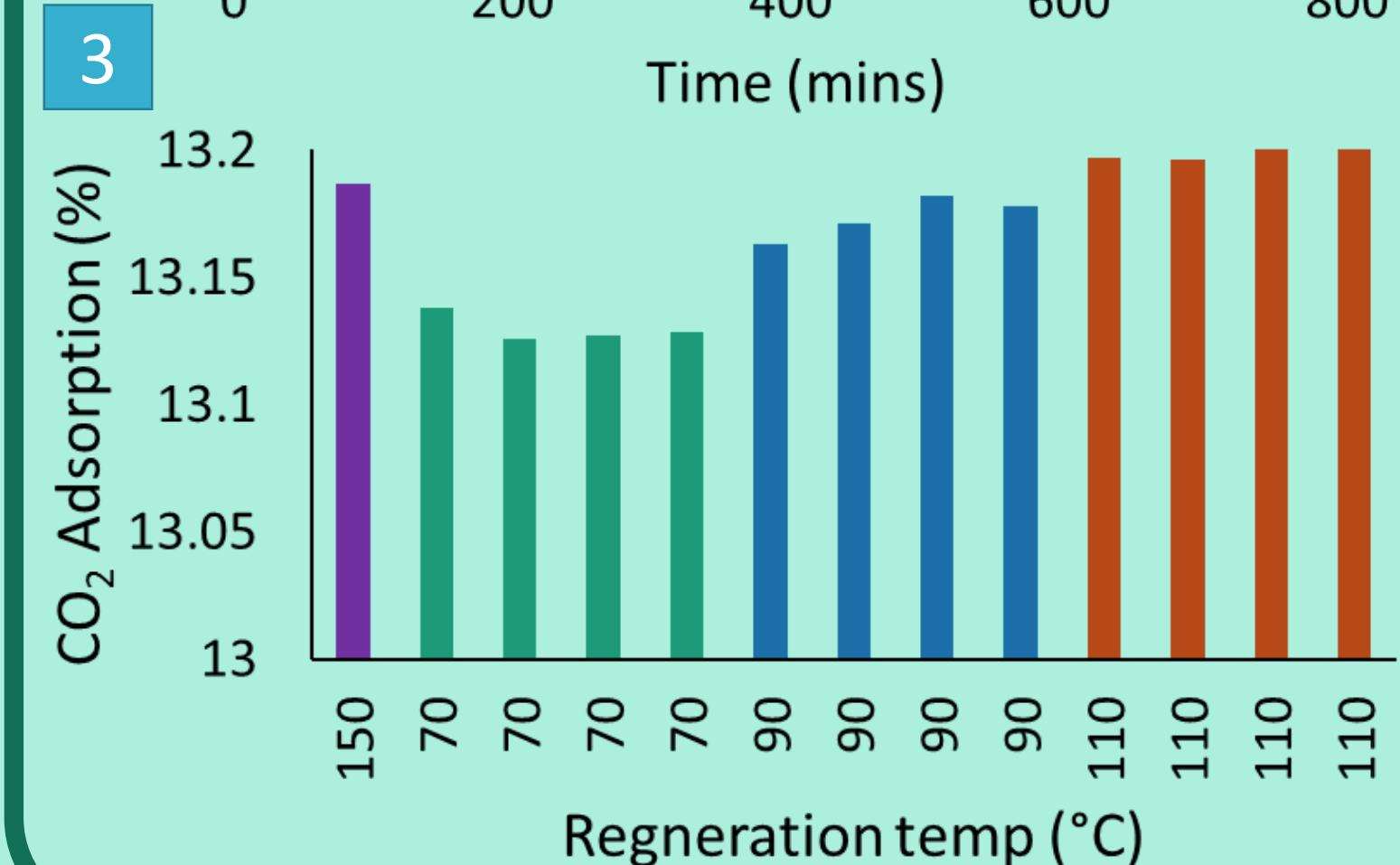


Calcium iron oxide chosen due to magnetic properties, high porosity and scalable single-stage synthesis⁷

Magnetic induction heating allows rapid and energy-efficient heating of composites to release captured CO₂ and regenerate adsorbent, also counterbalancing poor thermal conductivity of MOFs⁸. Rapid heating demonstrated with microspheres (204 kHz):

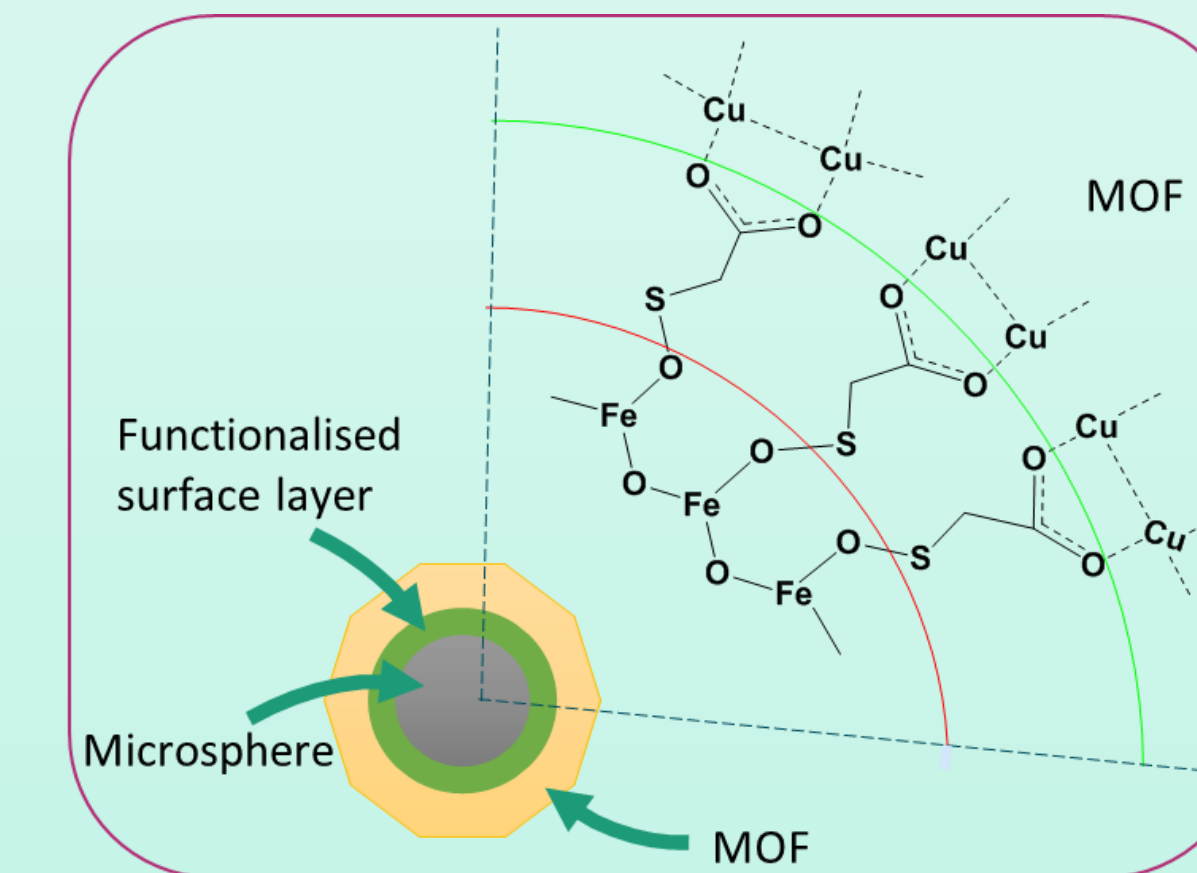


UTSA-16(Zn) shows excellent recyclability during CO₂ adsorption/desorption (1 bar) at different temperatures:

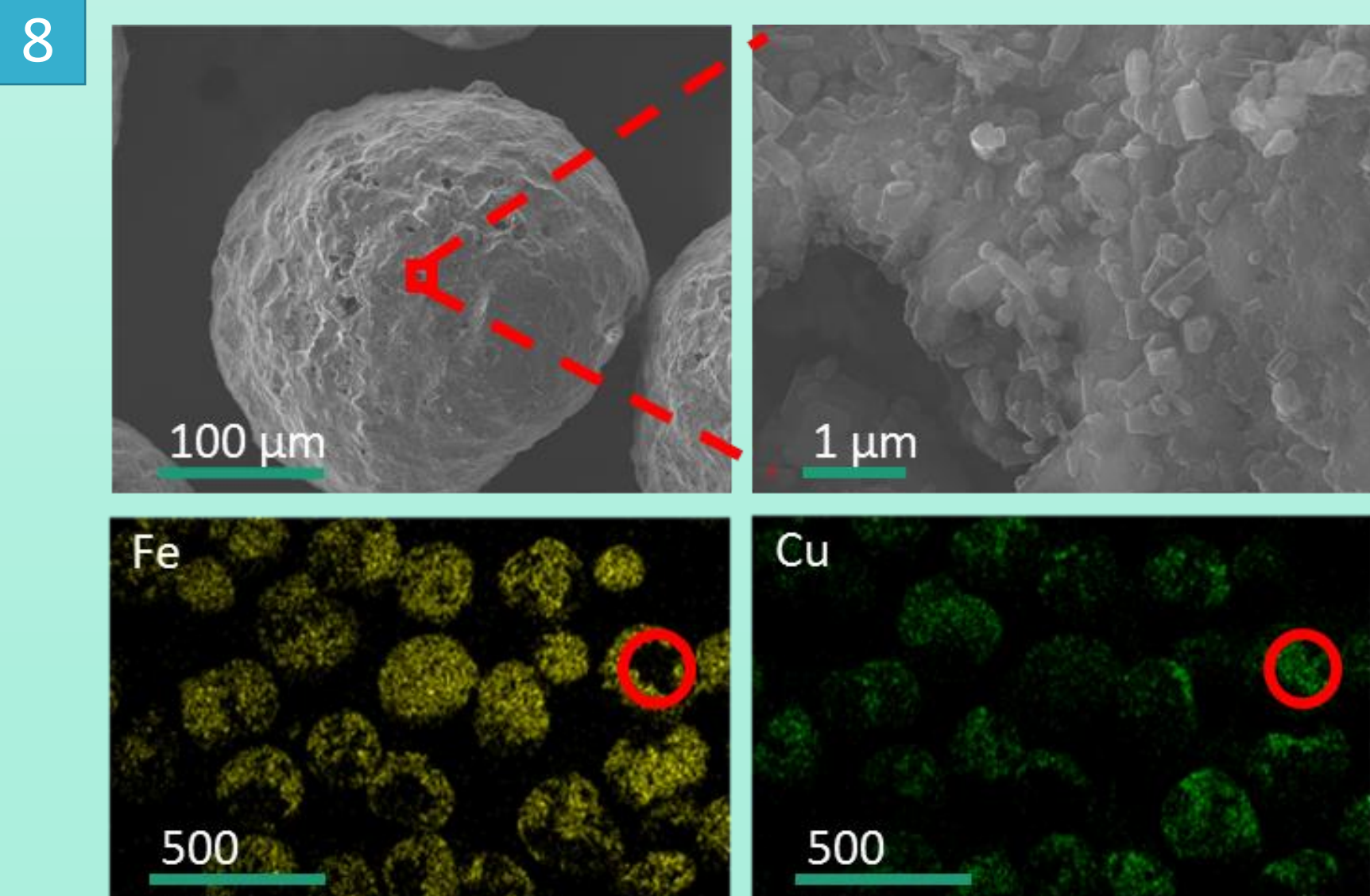
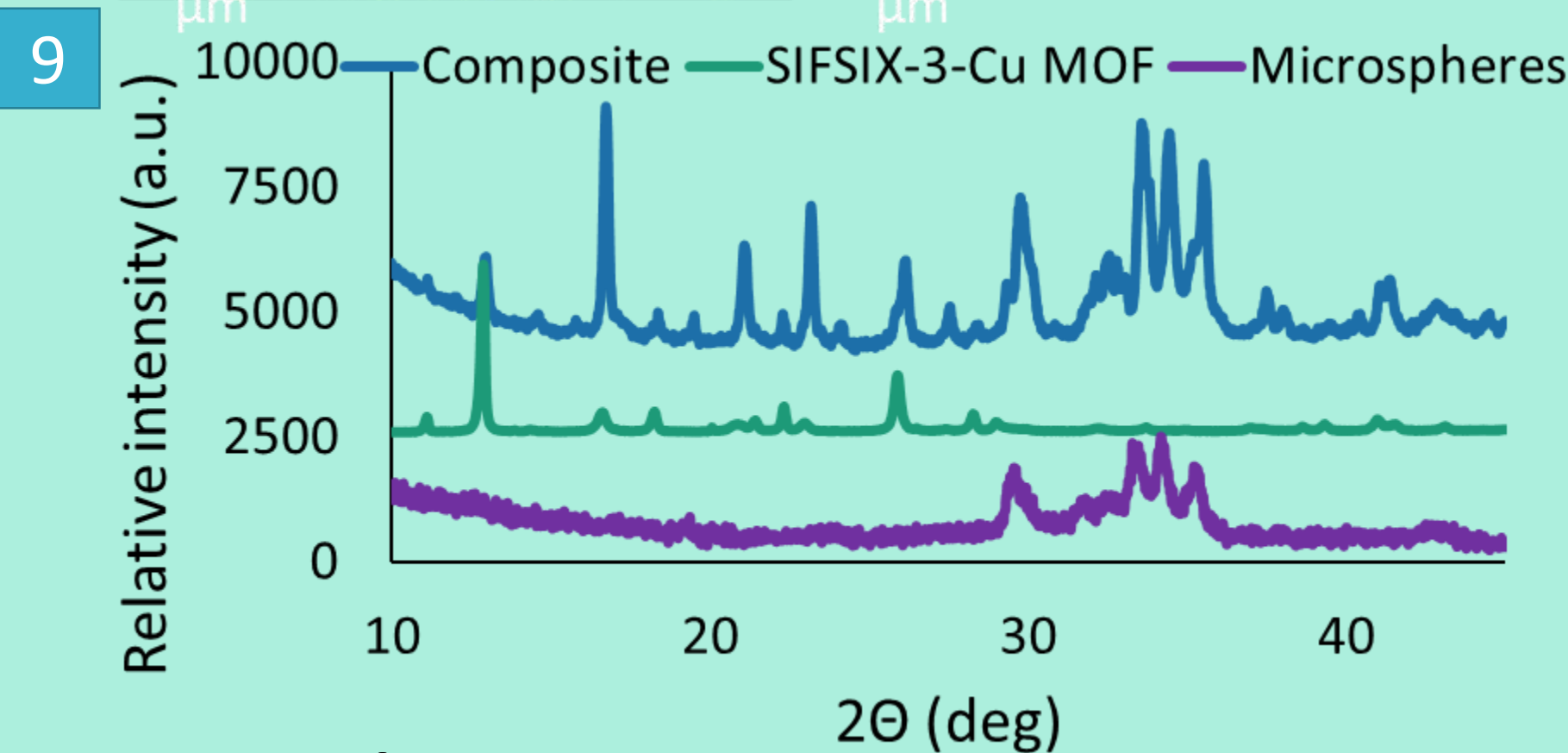


3 magnetic framework composites

Combined benefits of MOFs and microspheres!



SEM images show PDA/MYPR microspheres (containing Fe) coated with MOF nanocrystals (containing Cu), confirmed by EDX elemental analysis and powder X-ray diffraction:



Future work:

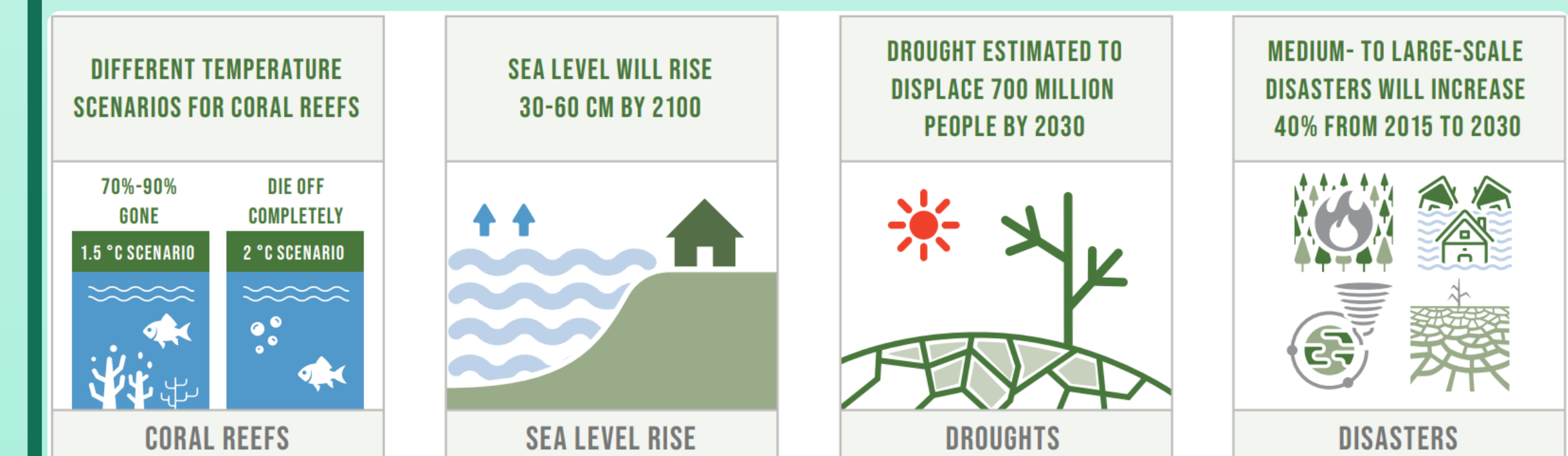
- CO₂ uptake and induction heating tests on composites
- Try magnetite nanoparticles with MOFs, compare to microspheres

The Goals⁹



SUSTAINABLE DEVELOPMENT GOALS
17 GOALS TO TRANSFORM OUR WORLD

13 CLIMATE ACTION



1 NO POVERTY



2 ZERO HUNGER



References

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