CENTER FOR INNOVATION IN CARBON CAPTURE AND STORAGE

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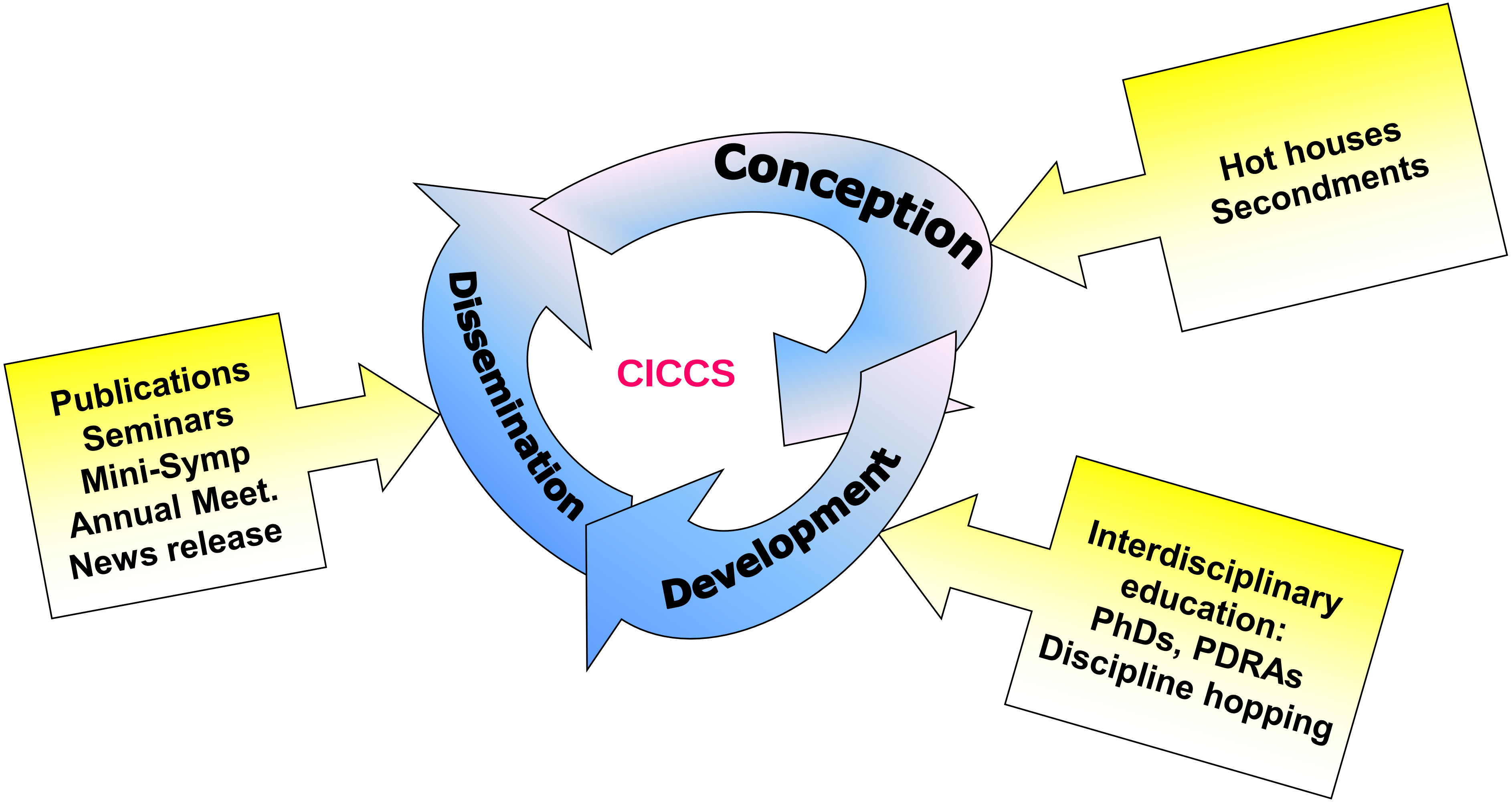
CICCS Vision

An interdisciplinary, innovative, and international leading centre for innovation in carbon capture and storage that will provide the mechanisms for a creative, multidisciplinary team to answer to the integrity challenges related to CO_2 storage.

Funded under the EPSRC Challenging Engineering Programme of EPSRC; £1.1m

CICCS: Implementation strategies



Partners / Stakeholders
Supporting Organizations

- **University of Nottingham**

  Chemical and Environmental Engineering, Geography, Biosciences, Mathematics, Chemistry

- **Industries**

- **International energy policy advisors and government organizations**

- **National and international universities and research centres**

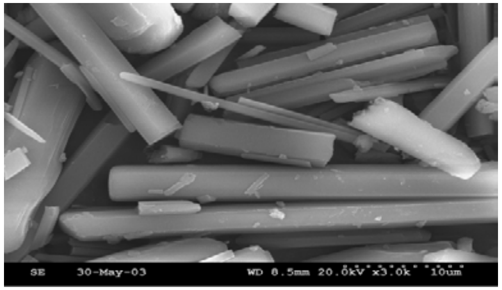
Mineral Carbonation: Lock it in Rock

Mineral Carbonation – the chemical fixation of CO_2 in minerals to form geologically stable mineral carbonates

(1) Olivine

(2) Serpentine

+ CO_2 →



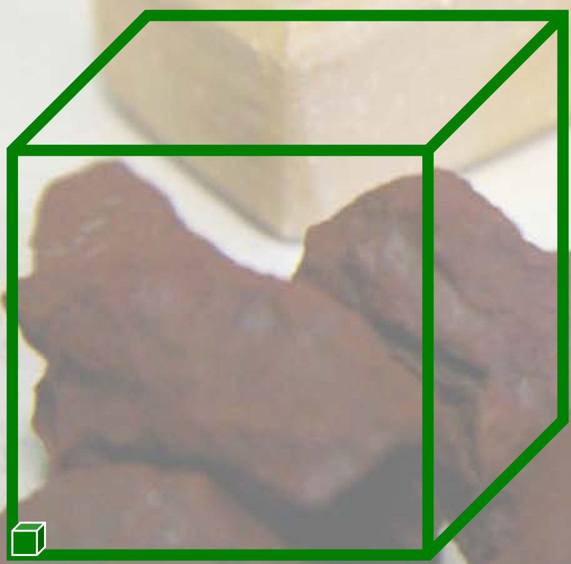
Reaction	△G
$(1) Mg_2SiO_4 + 2CO_2 \rightarrow 2MgCO_3 + SiO_2$	-209 kJ/mol
$(2) Mg_3Si_2O_5(OH)_4 + 3CO_2 \rightarrow 3MgCO_3 + 2SiO_2 + 2H_2O$	-67 kJ/mol

Characteristics

- Thermodynamically favored
- Mimic natural weathering
- Slow reaction kinetics

Advantages of the locked-up process

Each block is 40% weight CO_2 stored and contains 3 litres of CO_2



1,500 times more space to store in gas form

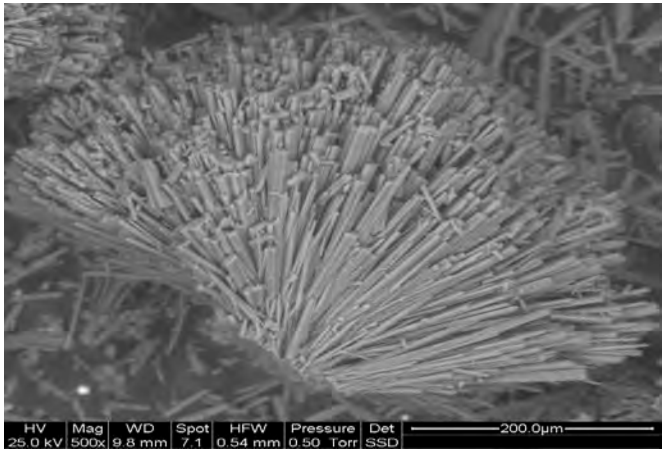
AND

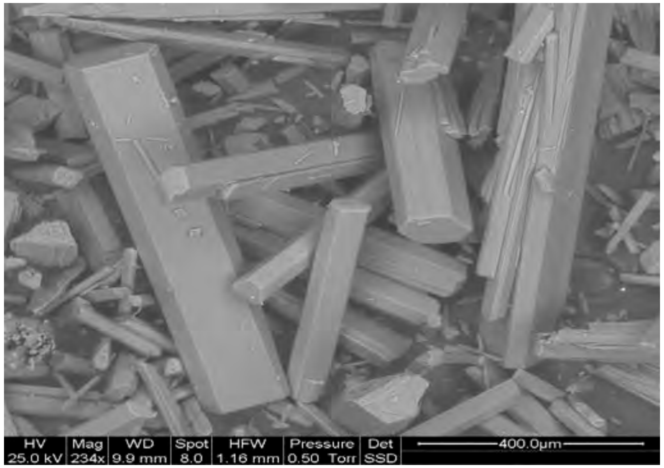
- Long term stability
- Useful end product

Centre for Innovation in Carbon Capture and Storage, CICCS-Funded by EPSRC

Below-ground mineralization / Storage at point of capture

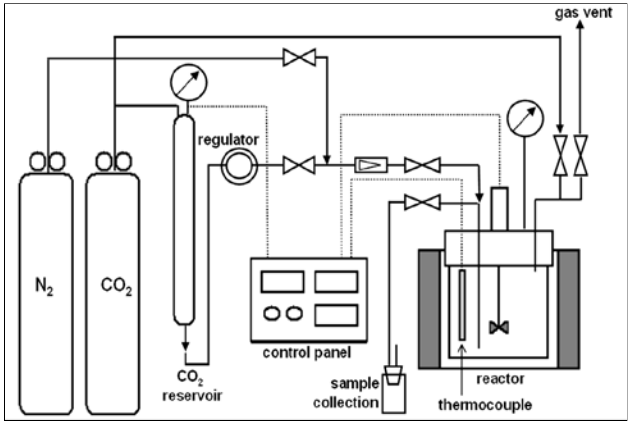
- Ferric iron sediments (red beds) can have the potential to store CO_2 in siderite.
- The benefits of developing this idea are twofold:
  - ferric iron can be used to store CO_2
  - storage can also be conducted at the point of capture as sulphur dioxide (SO_2) and other acidic gases present in the flue gas
- Further exploration of CO_2 capture and storage using red muds.





Carbon Sequestration in Geological Formations-1

- Injection of CO_2 into subsurface saline formations
- US deep saline aquifers: 130 gigatons carbon equivalent ~ 80 times
- Following injection below depth of 800m:
  - Solubility
  - Hydrodynamic trapping
  - Mineral trapping

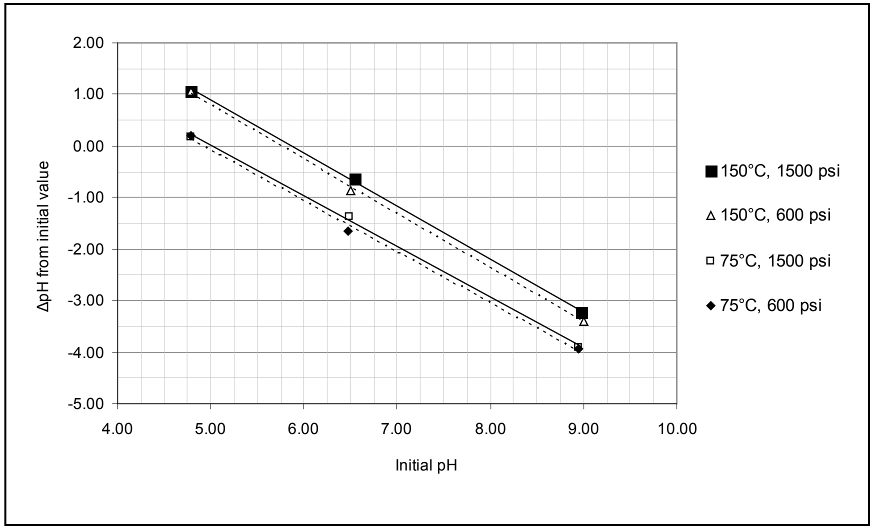


- Brine formations have the largest potential

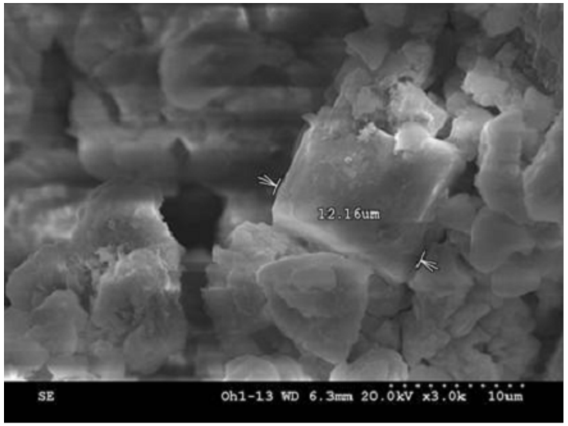
  for CO_2 sequestration in geologic formations.
- Our studies have shown that brines provide a sink for CO_2 at various levels for different pressures, temperatures, and heating rates.
- Measuring/Mitigation/Verification

Carbon Sequestration in Geological Formations-2

- Calcite formation was induced at temperatures of 150°C, and pressures ranging from 600 to 1500 psi.
- Feasibility for an industrial scale operation to sequester carbon in natural gas well brine is currently limited by the extent that pH needs to be controlled.



Variation in pH as a function of initial pH during the CO_2/brine reactions



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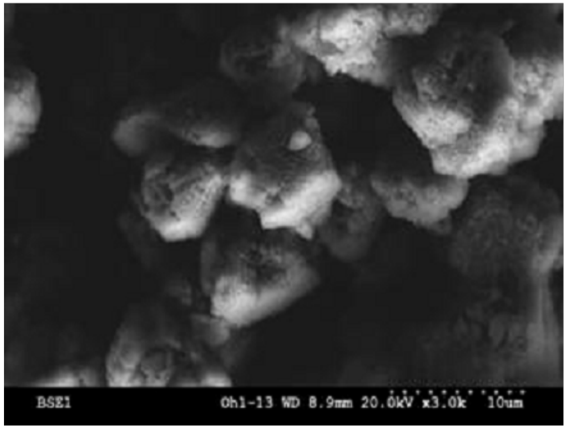


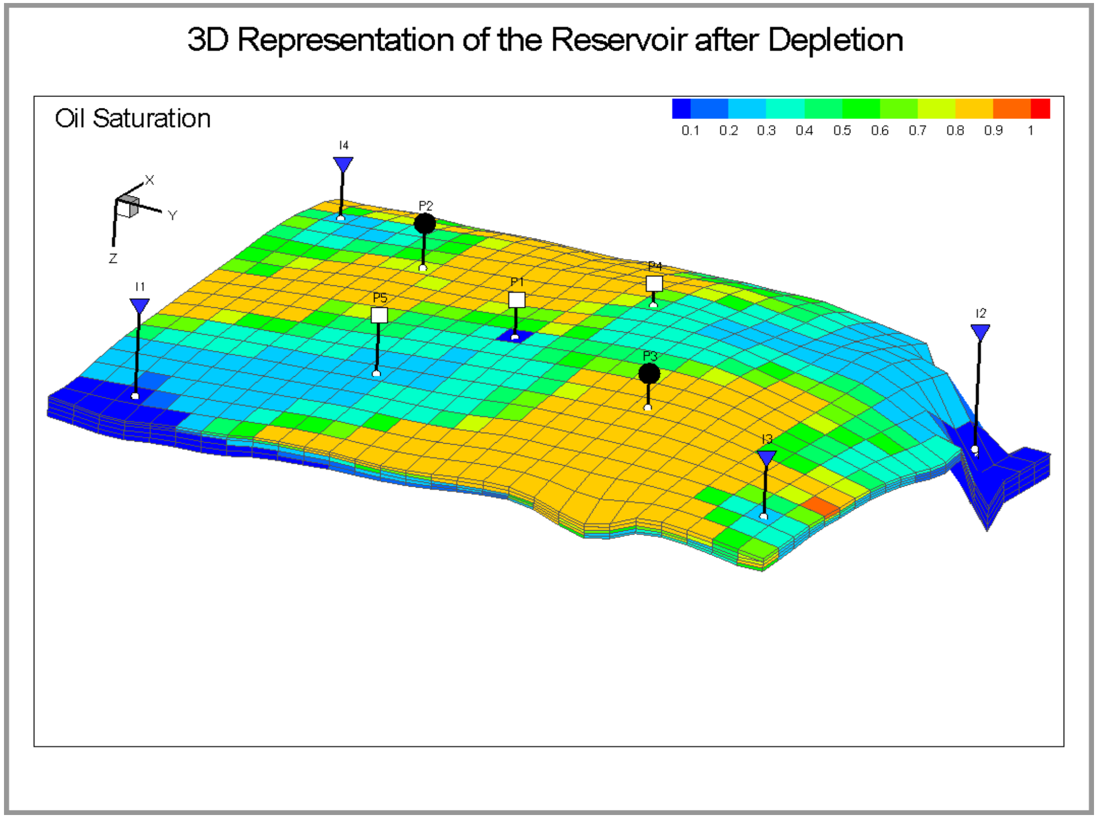
b

SEM images of a calcite precipitate

M. L. Druckenmiller and M. M. Maroto-Valer, Fuel Processing Technology, 86 (2005) 1599–1614 and Energy & Fuels, 20 (2006), 172-179.

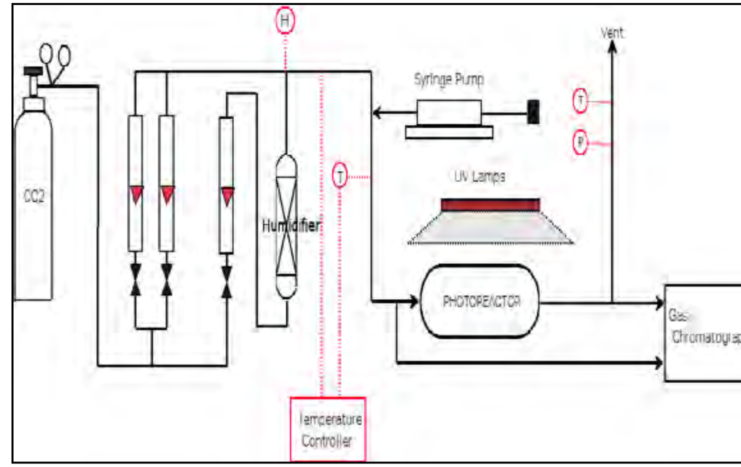
Carbon Sequestration in Geological Formations-3

- Synthetic brines.
- Source rock-brine interactions.
- Mimic the well conditions.
- Computer simulation of injection in depleted wells.



Harnessing solar light energy to convert CO_2 into fuels

Natural photosynthesis



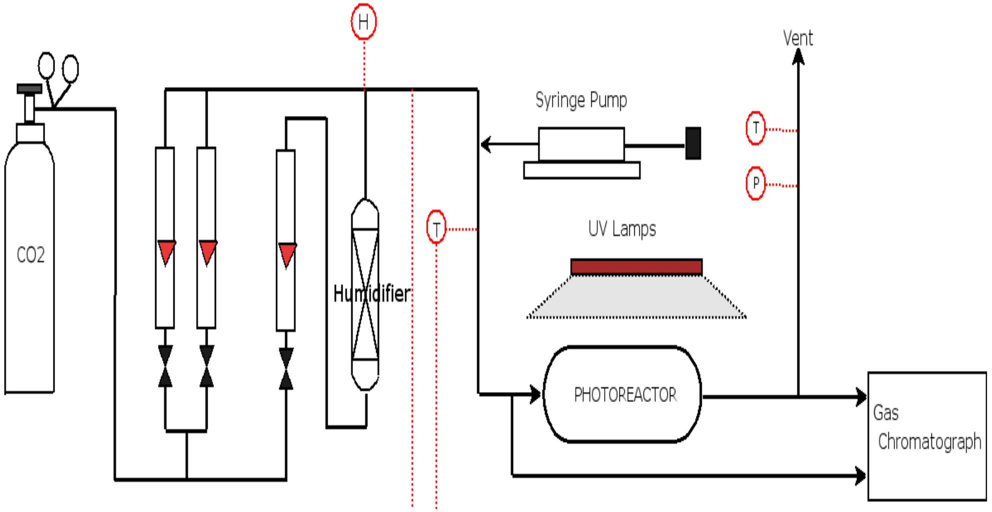
Artificial photosynthesis

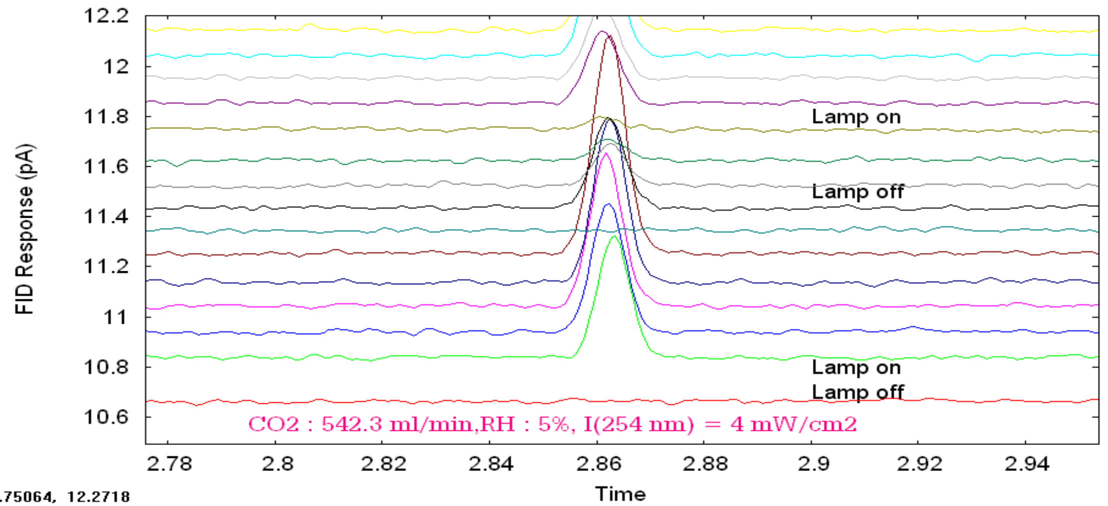
- It is possible to use red shift in doped titania to mediate the photochemical reduction of CO_2 with water using UV/visible light.
- Implications of this work:
    - Close energy cycle
    - Fuel for missions to Mars

Photoreduction of CO_2: Harnessing solar light energy to convert CO_2 into fuels

- It is possible to use red shift in rare earth doped titania to mediate the photochemical reduction of CO_2 with water as the reductant using near UV/visible light.

- It is possible to mediate photoreduction with longer wavelengths than currently used in the literature ($\lambda > 280$ nm) when supported rare earth doped titania is used.





Activities: On-going and Planned

- **RESEARCH**
  - **Multidisciplinary approach**
  - **From basic science to end-users**
  - **Wide range of on-going programmes**
  - **Invested £0.5m equipment/facilities**

- **TRAINING**
  - **Generation of academic, industrial and government leaders**
  - **Involvement of industries in postgraduate training**
  - **Workshops/continuing education**

- **OUTREACH**
  - **Public engagement programmes**
  - **Corporate social responsibility**

Opportunities for collaboration

- Multidisciplinary approach
- From basic science to end-users
- Involvement in CICCS's activities: launch event, workshops, hot houses
- Discipline hopping

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