Towards net-zero: New line of multifunctional nanomaterials for CO_2 capture and photoreduction

Investigation of P doping on porous BN properties

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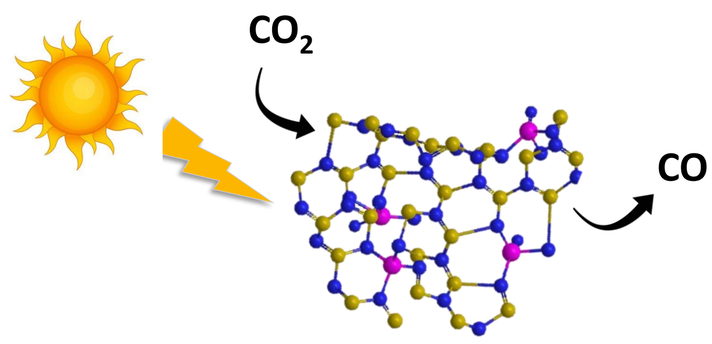
Motivation

The production and use of sustainable fuels it key to achieving **UK net-zero** target by 2050. Photocatalytic CO_2 reduction provides a green pathway towards this goal, combining **solar energy** with **CO_2 utilization**. For this application, it is crucial to develop photocatalysts with visible light absorption and good photocatalytic activity.

Porous boron nitride (BN) has proven to be a promising material for CO_2 photoreduction. **However**, its activity remains too low for further deployment. **Tuning** porous BN by introducing **phosphorus** (P) into the structure can modify its chemistry, and potentially help harvest more visible light.



Objectives

- ✓ To investigate how **P embeds** into BN's structure.
- ✓ To explore the **impact** of P doping on the chemistry, optoelectronic properties and photocatalytic activity of porous BN.

Methods

Synthesis
Boric acid + Melamine
+ Ionic Liquid (IL) or Phosphoric Acid (PA)

Chemical and structural properties
ATR FTIR, XPS, XANES/NEXAFS, XRD, N_2 sorption at -196 °C

Optoelectronic properties
DRS UV/Vis, EPR, PL, TAS, TCSPC

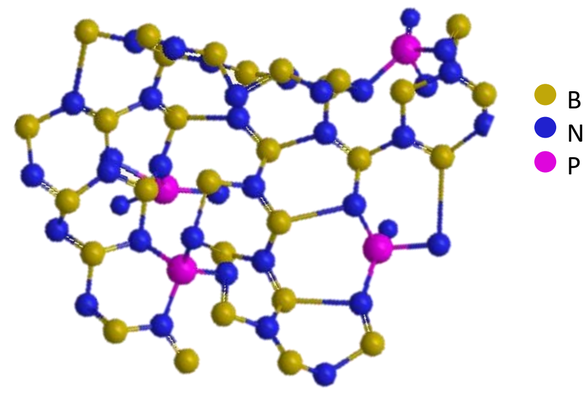
CO_2 capture and photoreduction
CO_2 sorption at 25 °C, gas/solid photocatalytic tests

Results

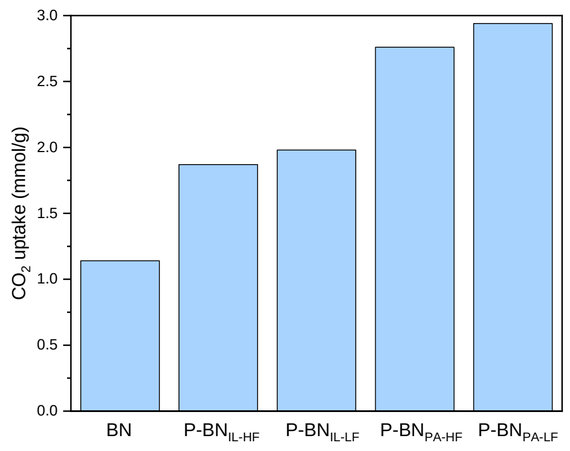
- ✓ **Successful P doping** – creation of B-N bonds.
- ✓ **Enhanced** CO_2 adsorption in P-doped samples.
- ✓ **Visible light active** photocatalysts.

Chemical structure & environment

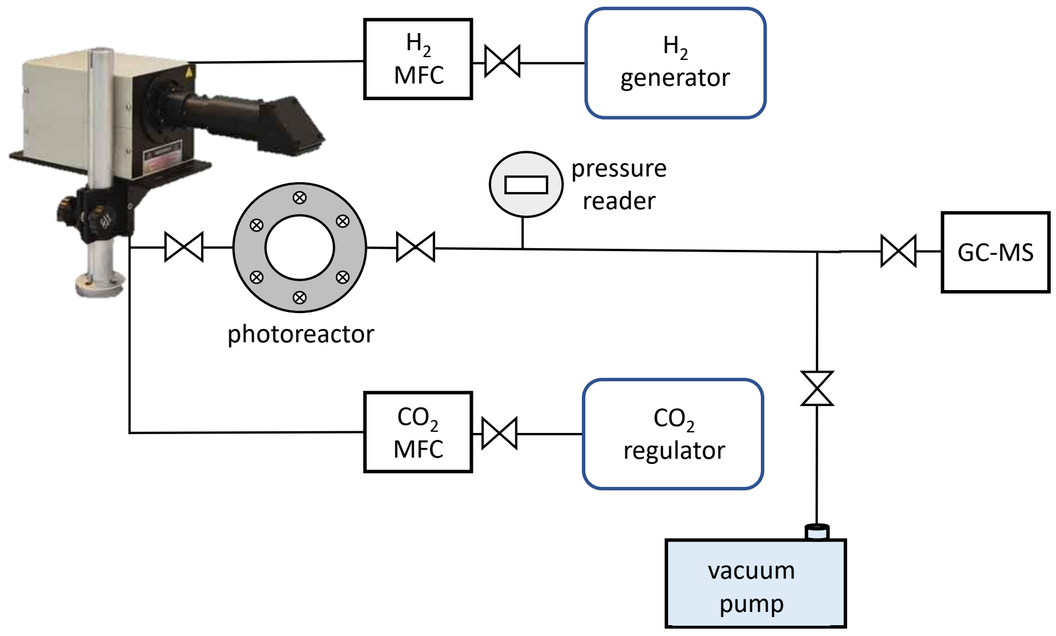
Sample	P (at %)
$P\text{-}BN_{IL\text{-}HF}$	2
$P\text{-}BN_{IL\text{-}LF}$	3
$P\text{-}BN_{PA\text{-}HF}$	3
$P\text{-}BN_{PA\text{-}LF}$	4



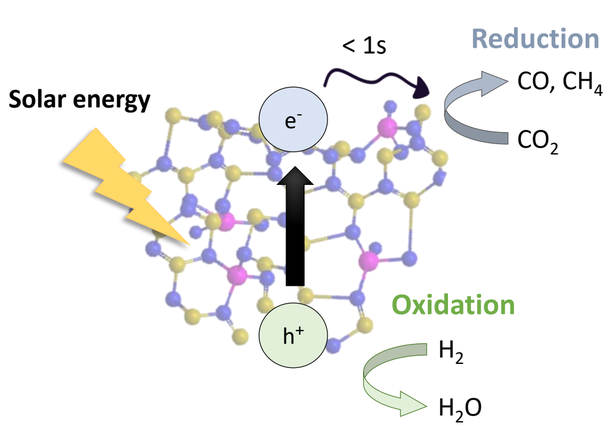
CO_2 uptake (25 °C, 1 bar)

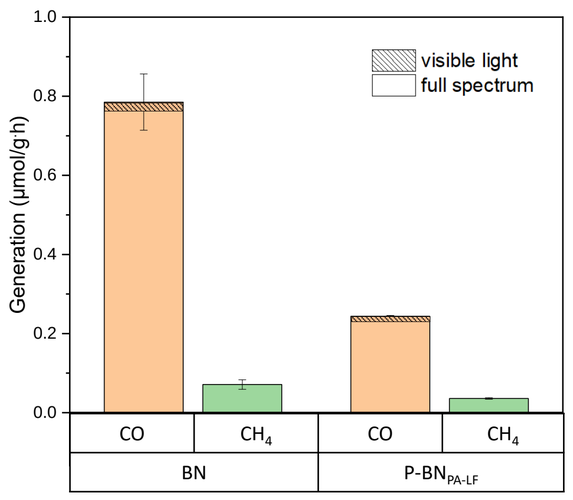


Experimental set-up



Light absorption and CO_2 photoreduction





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