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Low-temperature magnetic properties of porous carbon/sulfur composites under a hydrogen atmosphere

Charles D. Brewster, Lui R. Terry, Sebastian Rochat, Valeska P. Ting

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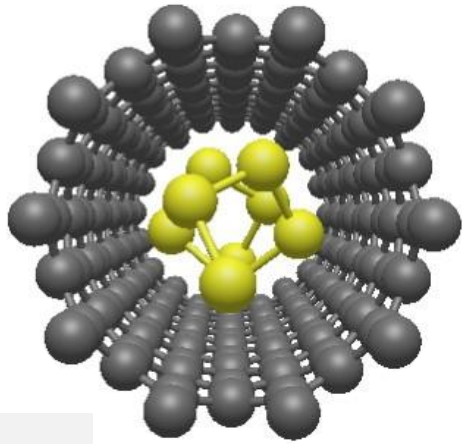
Context

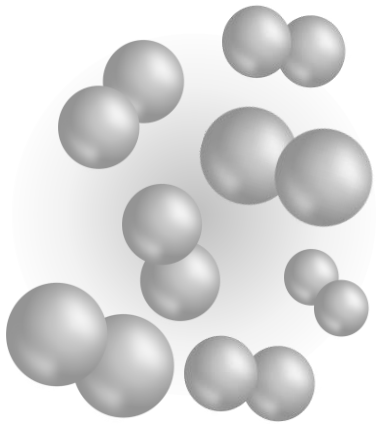
Why Study Magnetic Properties?

Understanding of the magnetic properties of nanocomposite material is necessary for in demand technologies e.g. spintronics, gas sensing, magneto-optic memory.



Why Sulfur/Carbon Composites?

Carbon/sulfur composite materials often display unusual magnetic properties (ferromagnetism, spin-glass, superconductivity etc.) and have shown beneficial properties for hydrogen storage.

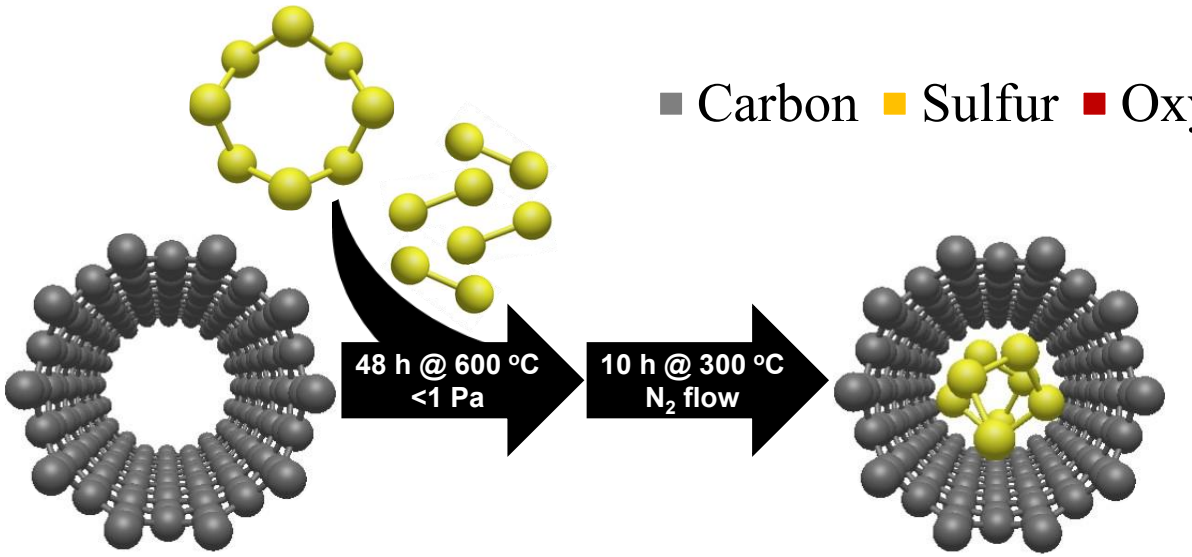


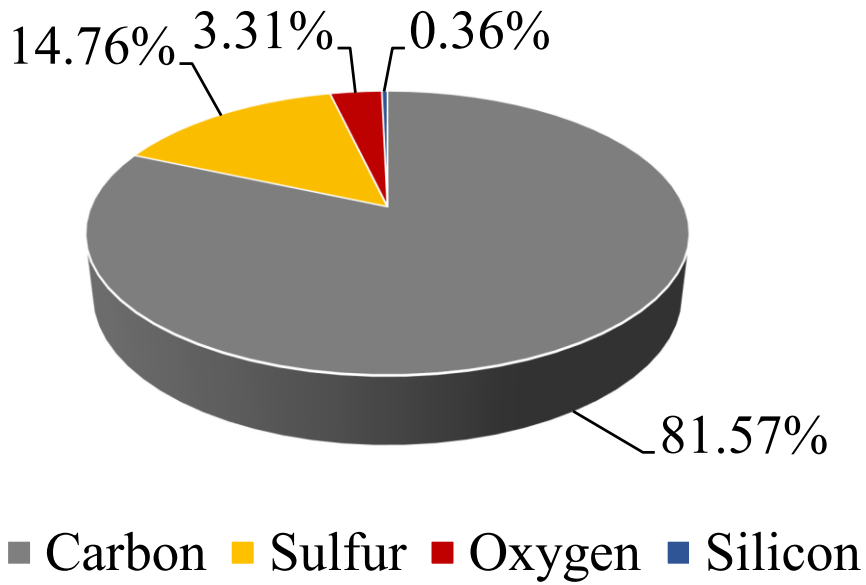
Development of New Hydrogen Technologies

Understanding fundamental interactions between hydrogen and materials may lead to new technologies to support the hydrogen energy economy.

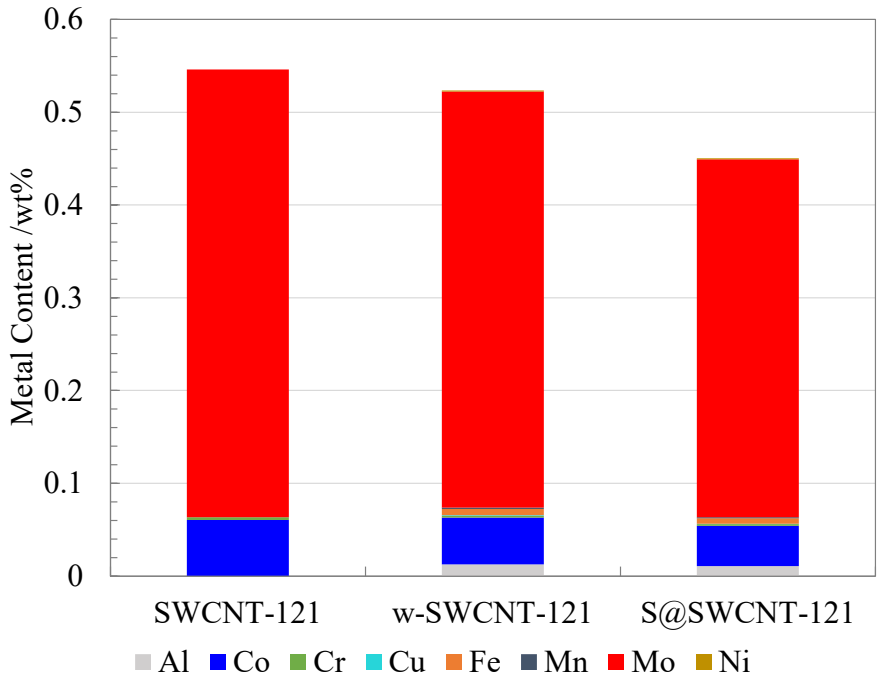
Sample Composition

Precursors are sealed in separate compartments of an H-shaped ampule under low pressure and then heated.



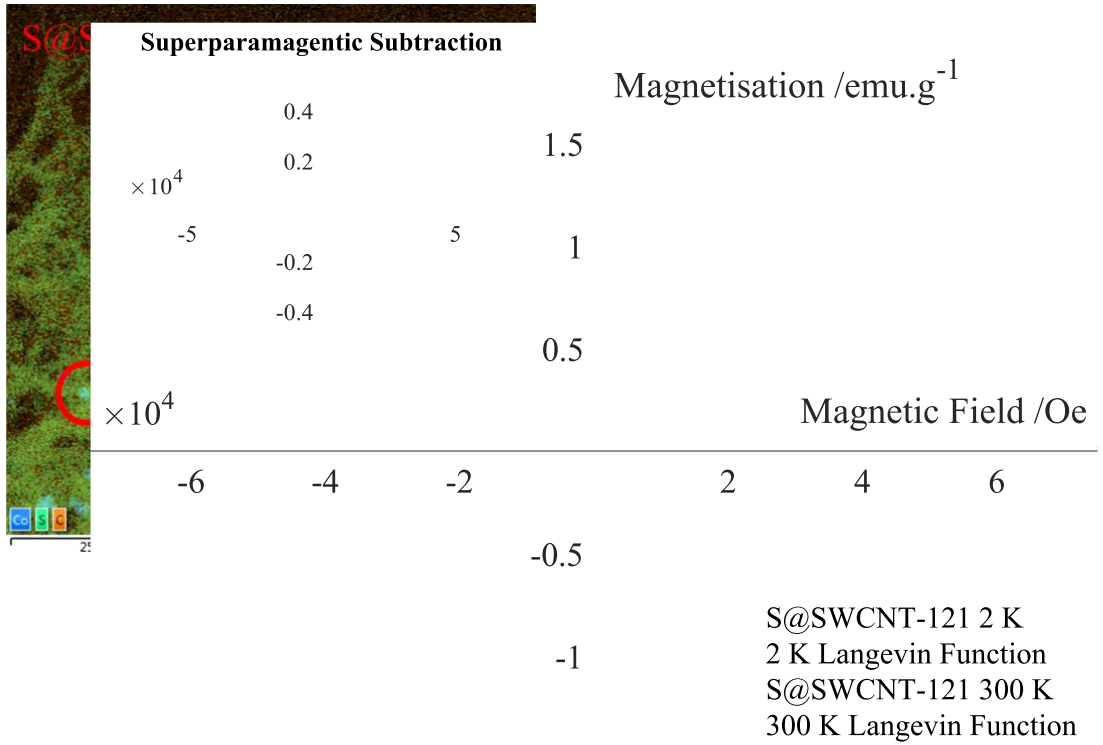


XPS survey spectra estimate 14.76 wt% of sulfur.



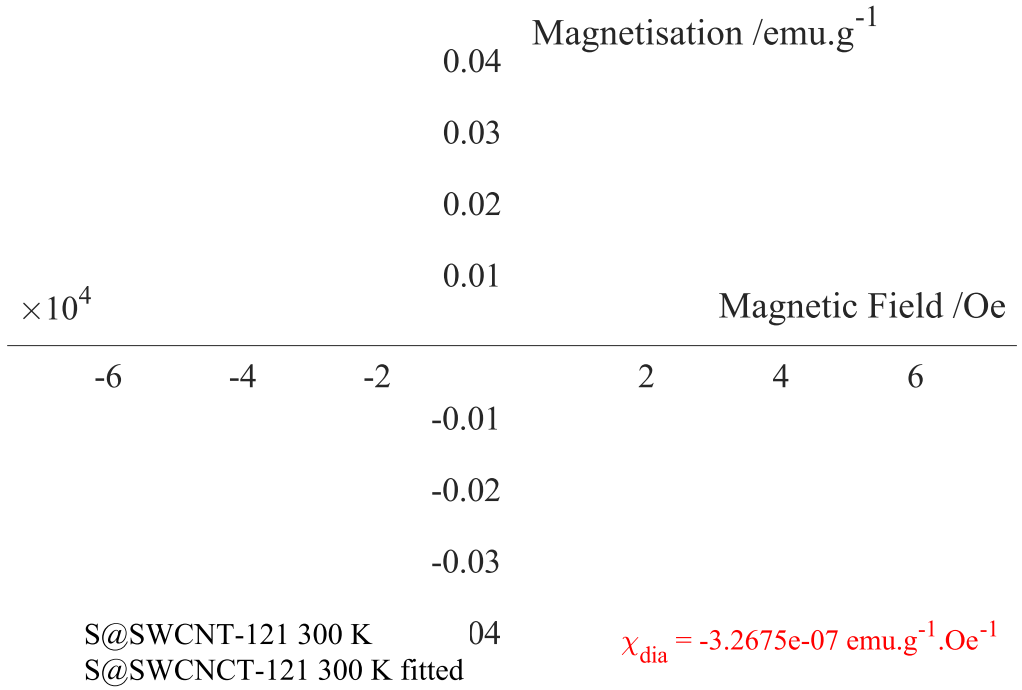
ICP-OES provides quantification of the metal content with the sample and shows the presence of residual catalytic metal.

Vacuum Magnetic Results



MvH curve shows a superparamagnetic response likely originating from embedded cobalt nanoparticles.

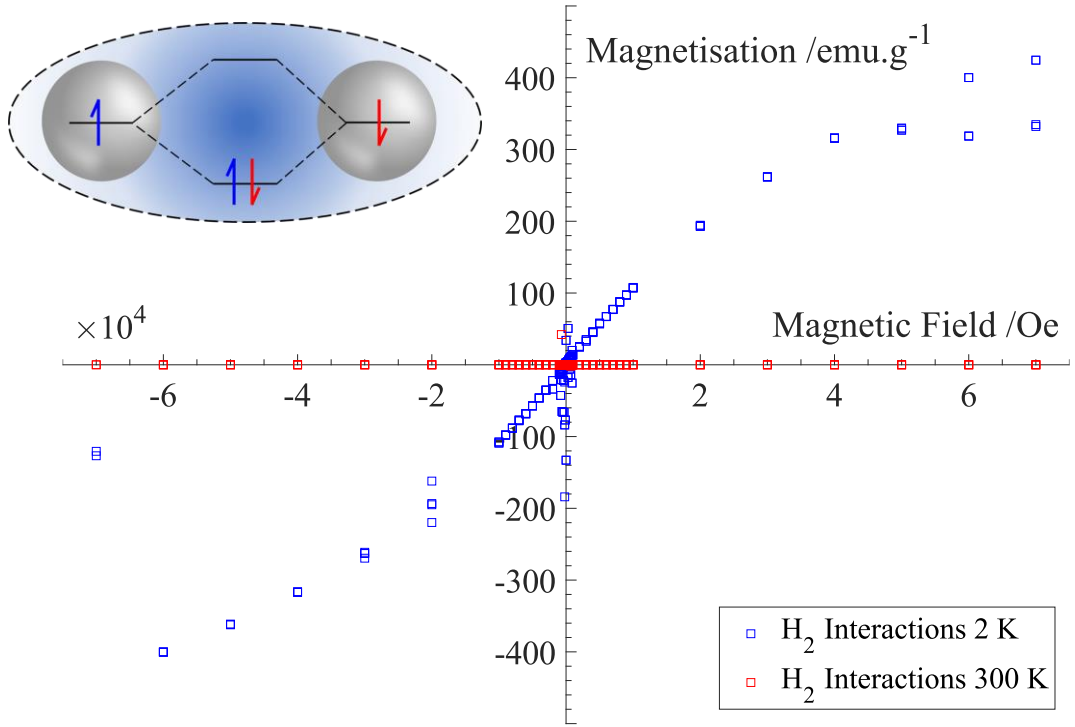
Residuals from fitting show additional diamagnetism and (possible antiferromagnetism) for the composite system.



$$M(H, 300\ K) = N \cdot \int_0^{\infty} \frac{M_{BS} \cdot \pi \cdot D^3 \cdot H}{6 \cdot k_b T} \cdot L(x) \cdot PDF(D)\, dD$$

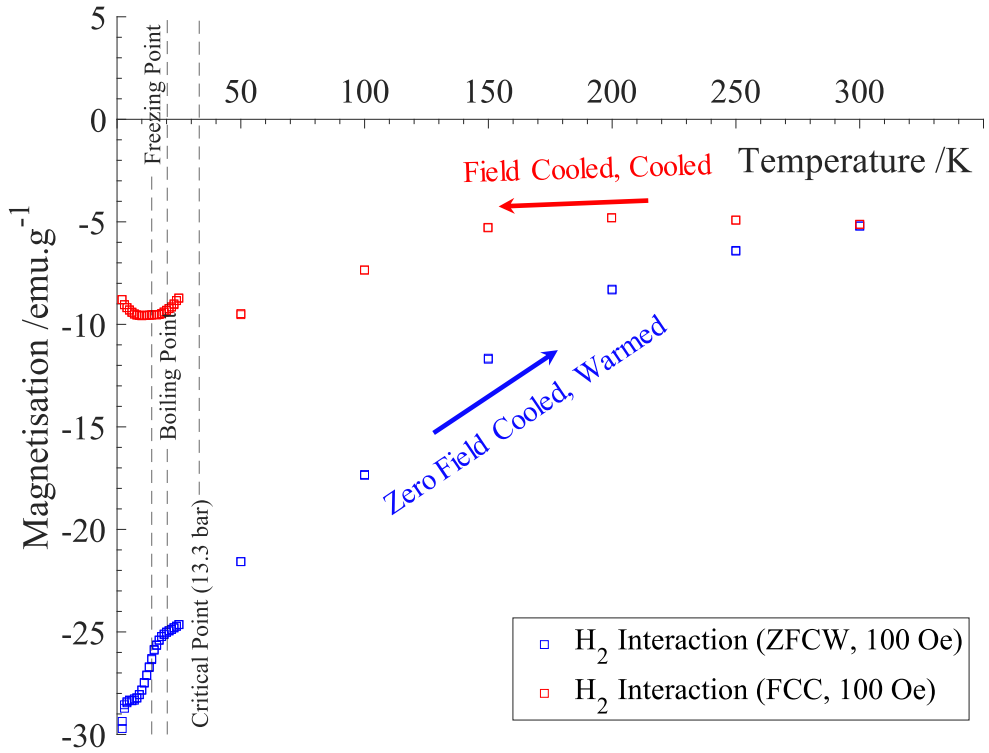
Parameter	N /g^{-1}	$\widetilde{D_{mag}}$ /nm	$\sigma_{D_{mag}}$	χ_{dia} /emu.g^{-1}.Oe^{-1}
Value	$10^{14.7}$	4.2	±0.3	-3.3×10^{-7}

100 mbar H_2 Magnetic Results



At low fields, there is a general diamagnetic subtraction due to the presence of hydrogen.

Cooling whilst in a field provides an enhancement to paramagnetic contributions.



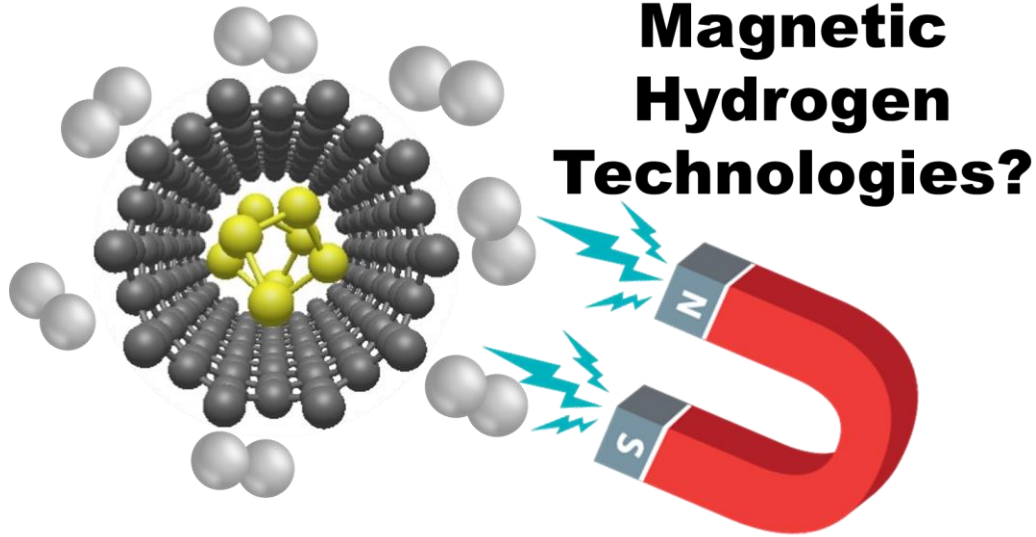
Increase in paramagnetic response due to interactions with hydrogen at low temperatures.

Change in magnetic response due to hydrogen strictly limited to cryogenic conditions.

Conclusion and Future Work

Conclusion

- Magnetic response is heavily dominated by residual ferromagnetic nanoparticles.
- Interactions with hydrogen cause a measurable change of the composite system.
- Phase changes in hydrogen detected by the magnetic response.



Future Work

- Experimentation of different carbon/sulfur samples with fewer ferromagnetic impurities to elucidate the mechanism of hydrogen interactions.
- Conduct Magnetisation measurements with varying hydrogen pressures, temperatures and field strength.

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Thank you for listening. Please visit my poster for questions and discussions

c.d.brewster@bristol.ac.uk

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