Fuel Gas Storage – The Challenge of Methane

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Methane

- Methane combustion emits less carbon dioxide (high H to C ratio) than other fossil fuels and less SO_x and NO_x
- Can be used as a transition fuel for the use of even cleaner alternatives (e.g. hydrogen energy)
- Has a higher heating value of 55.50 MJ kg^{-1} (compared with hydrogen's 141.80 MJ kg^{-1} and gasoline's 47.30 MJ kg^{-1})

Methane storage

- As hydrogen, it has a very poor volumetric density (also a gas at normal pressure and temperature)
- To be used in vehicles, it has to improve on its volumetric density (amount per volume) using gas compression, liquefaction or by adsorption
- The goal is to test new porous materials for methane storage and investigate how adsorptive storage compares with other methods

Equipment

Clockwise from top left: X-ray diffractometer; IsoEx apparatus, Thermal Gravimetric analyser, HTP-1 volumetric sorption analyser, ASAP 2020 sorption analyser (centre), Helium pycnometer and IGA gravimetric sorption analyser

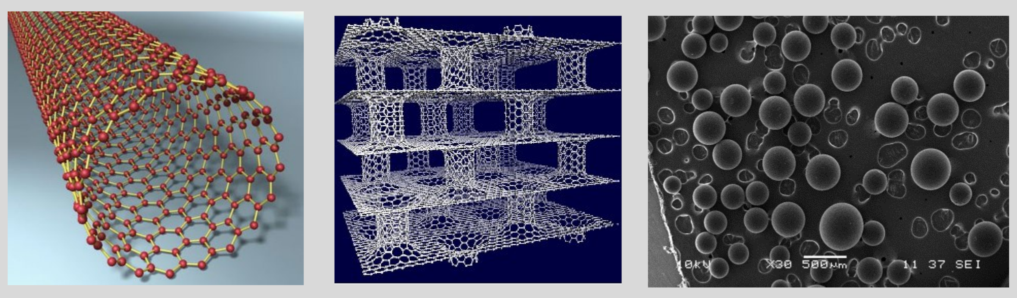
Porous Materials

Materials

Carbons

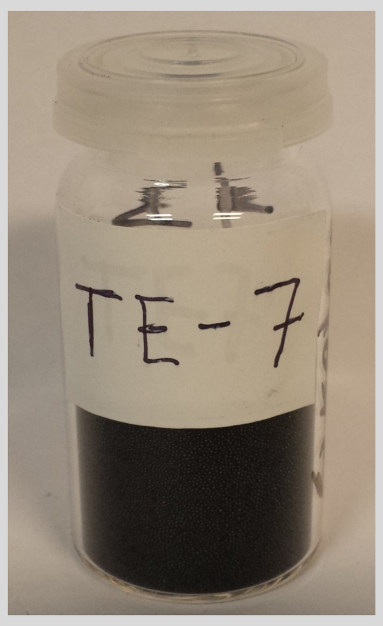
Advantages:

- Reversible, lightweight and cheap
- Wide variety of structural forms
- Good thermal stability
- Ability to modify the structure



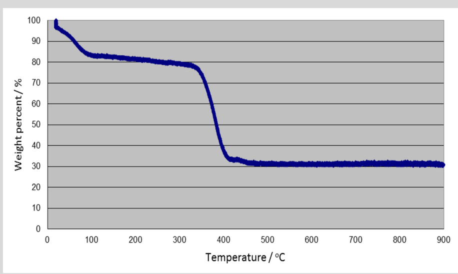
Nanotube, Pillared Graphene, carbon beads

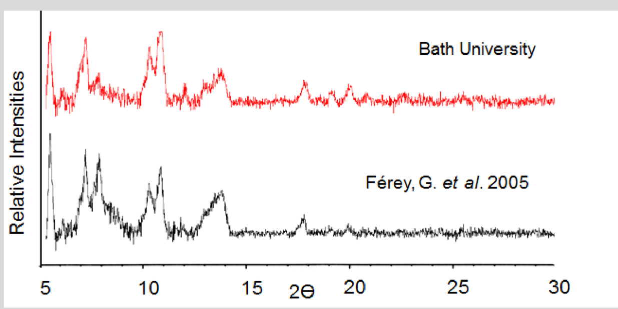
MAST TE7 Carbon Beads



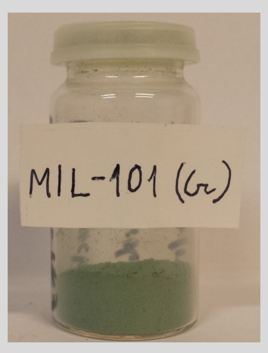
Metal-organic frameworks

- Metal centres strongly bonded to organic linkers
- High surface area
- Highly tuneable





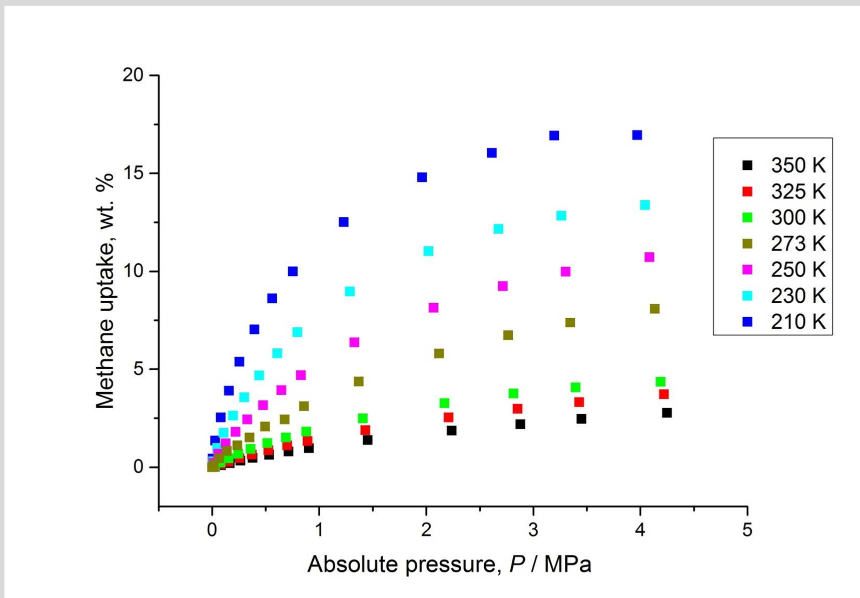
MIL-101(Cr) XRD and TGA



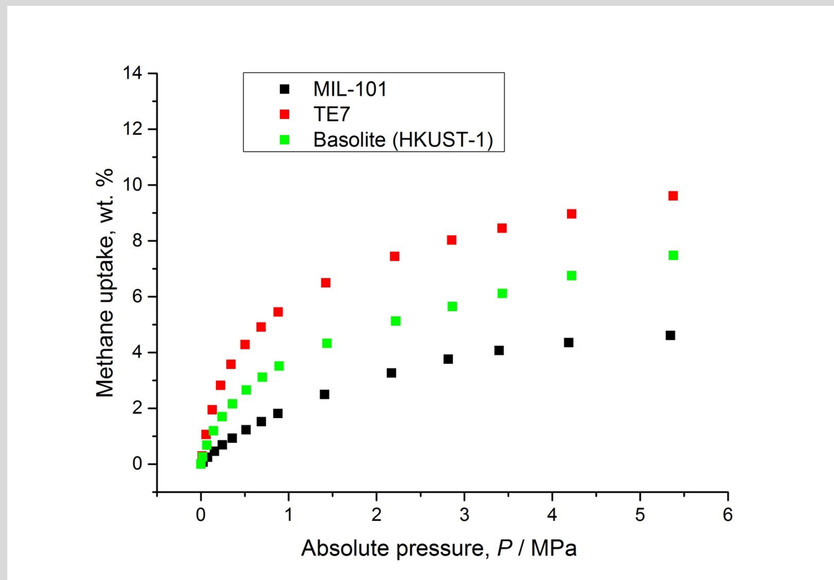
MIL-101 (Cr) and Basolite samples (HKUST-1)

Results

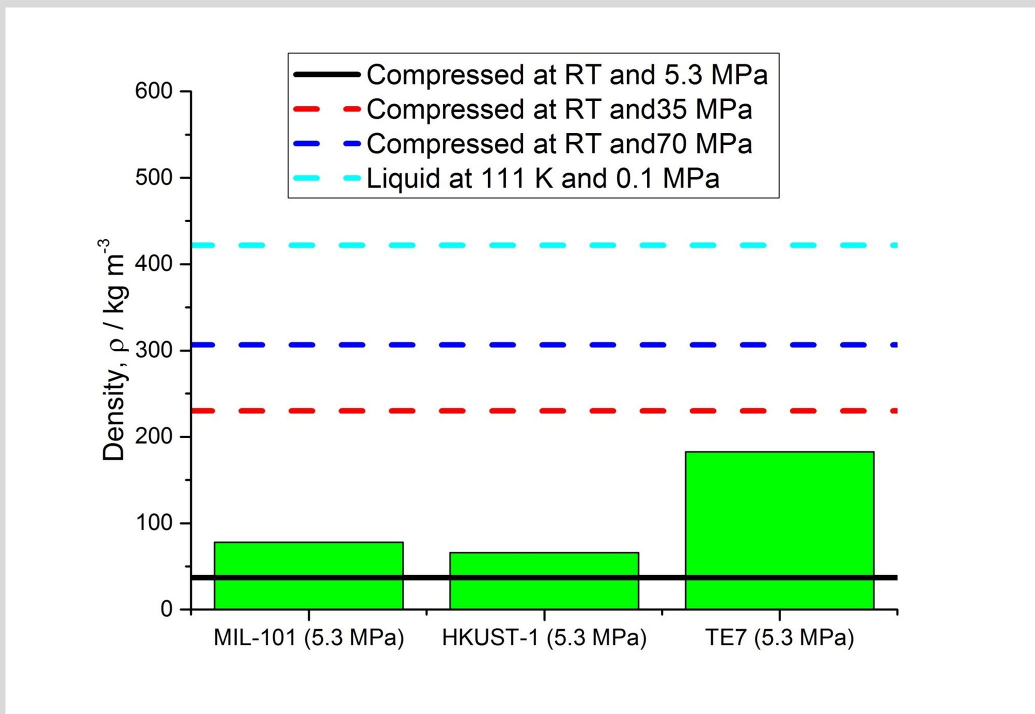
High – pressure methane isotherms



Experimental high-pressure methane excess for MIL-101



Experimental high-pressure methane excess at 300 K for MIL-101, TE7 and HKUST-1

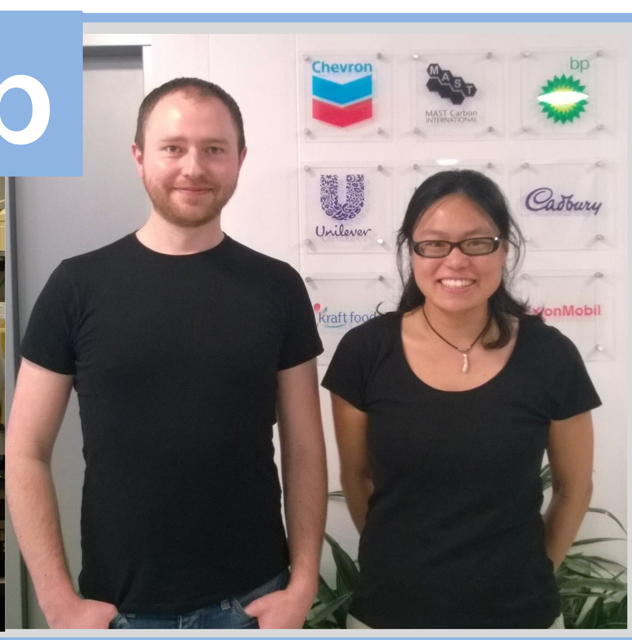


Comparative density of adsorbed methane at 300 K

TE7	MIL-101	HKUST-1
1.90	1.69	0.88

Density of materials (in g cm^{-3})

Group



References

- Peng et al,. J. Am. Chem. Soc. 2013, 135, 11887−11894
- Mason et al,. Chem. Sci. 2014, 5, 32-51

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