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# 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<sub>x</sub> and NO<sub>x</sub>
- 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<sup>-1</sup> (compared with hydrogen's 141.80 MJ kg<sup>-1</sup> and gasoline's 47.30 MJ kg<sup>-1</sup>)

### 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



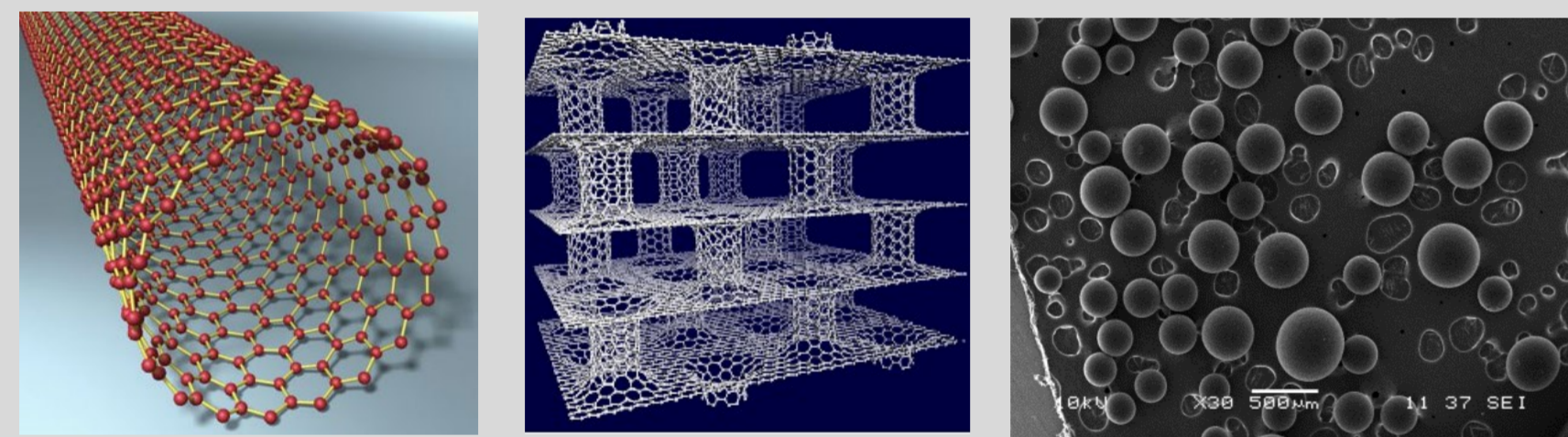
Clockwise from top left: X-ray diffractometer; IsoEx apparatus, Thermal Gravimetric analyser, HTP-1 volumetric sorption analyser, ASAP 2020 sorption analyser (centre), Helium pycnometer and IGA gravimetric sorption analyser

## Materials

### Carbons

Advantages:

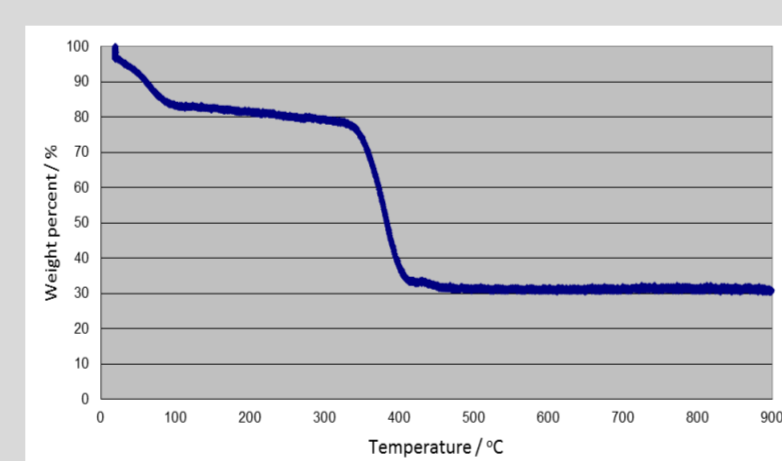
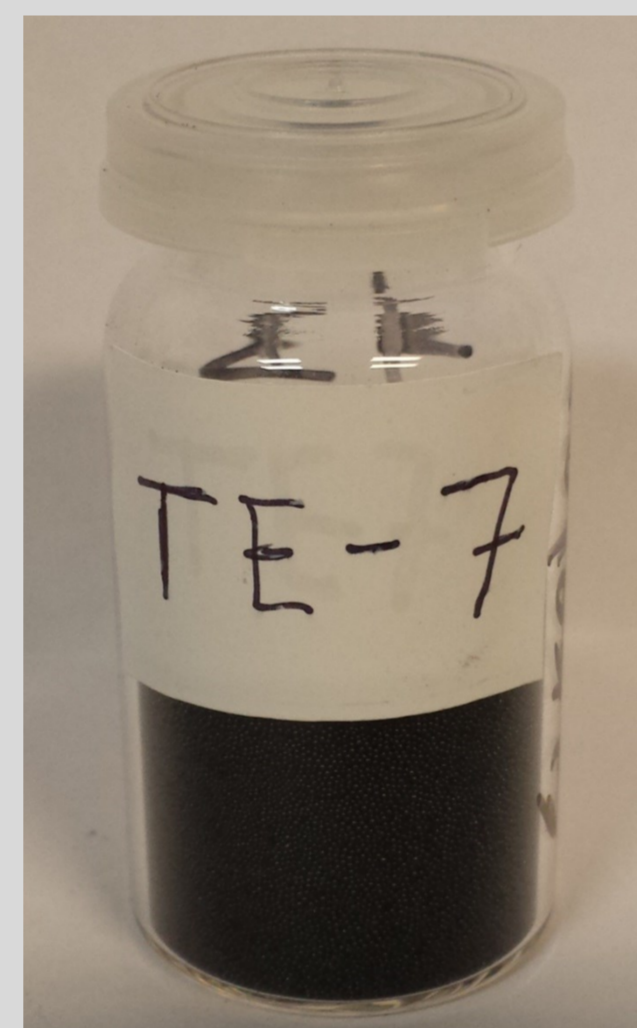
- Reversible, lightweight and cheap
- Wide variety of structural forms
- Good thermal stability
- Ability to modify the structure



Nanotube, Pillared Graphene, carbon beads

## Porous Materials

### MAST TE7 Carbon Beads

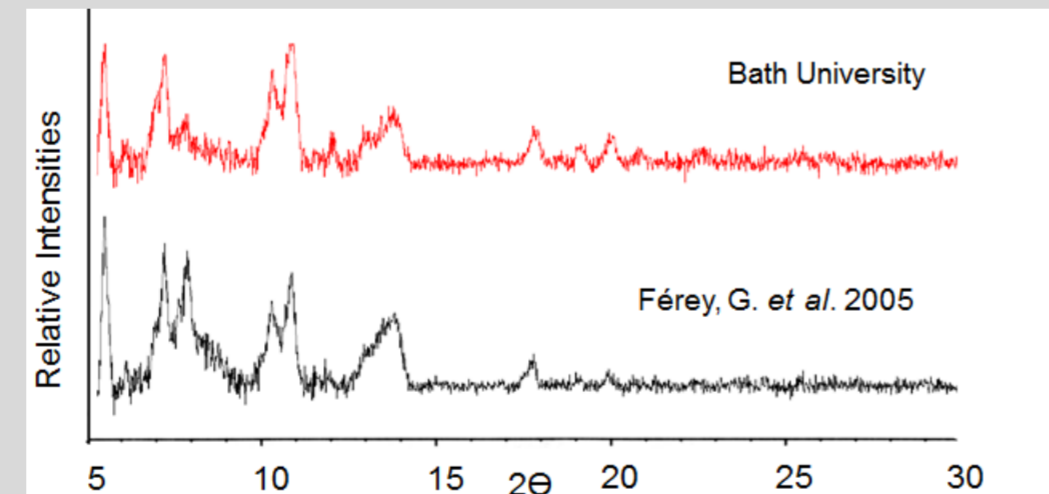


### Metal-organic frameworks

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



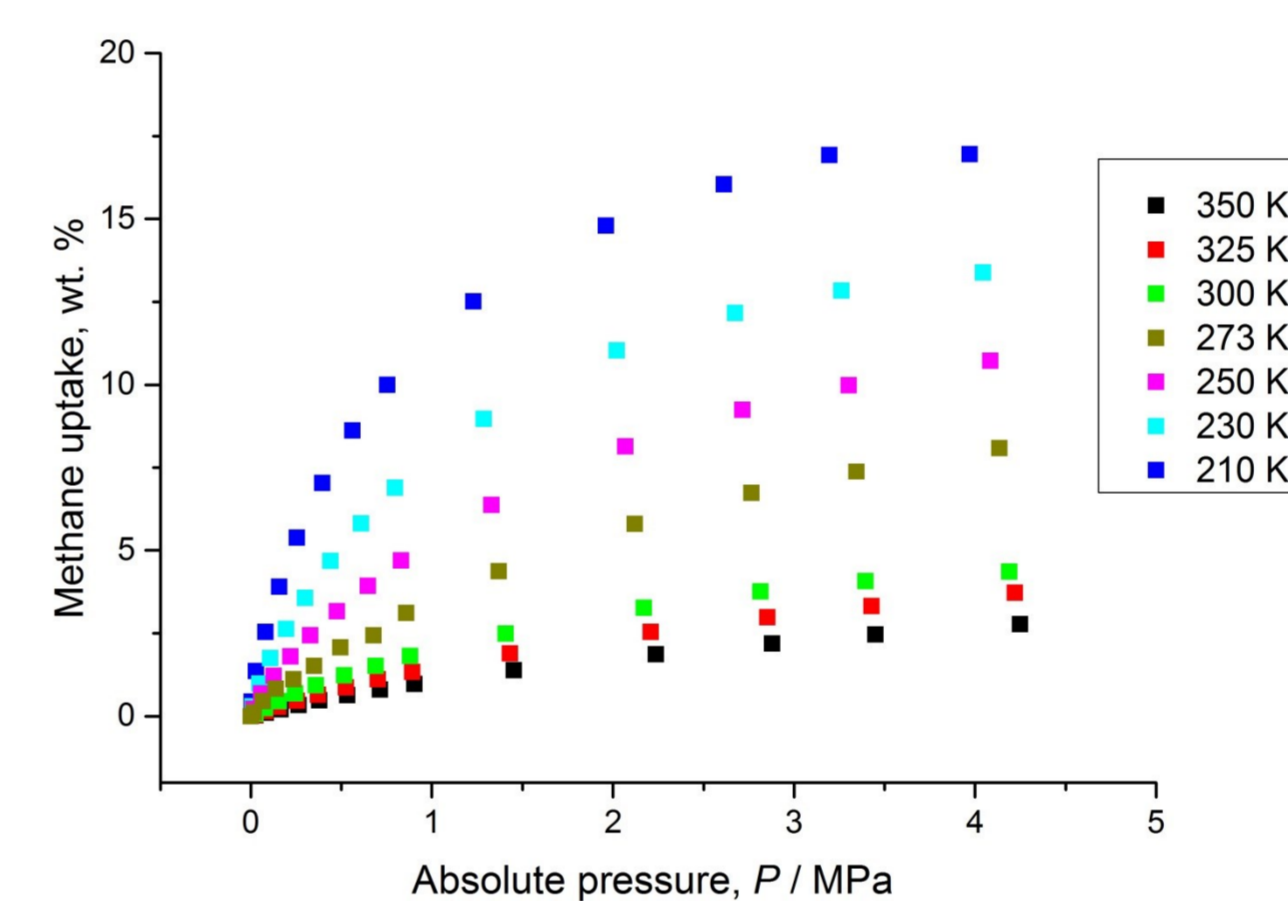
MIL-101 (Cr) and Basolite samples (HKUST-1)



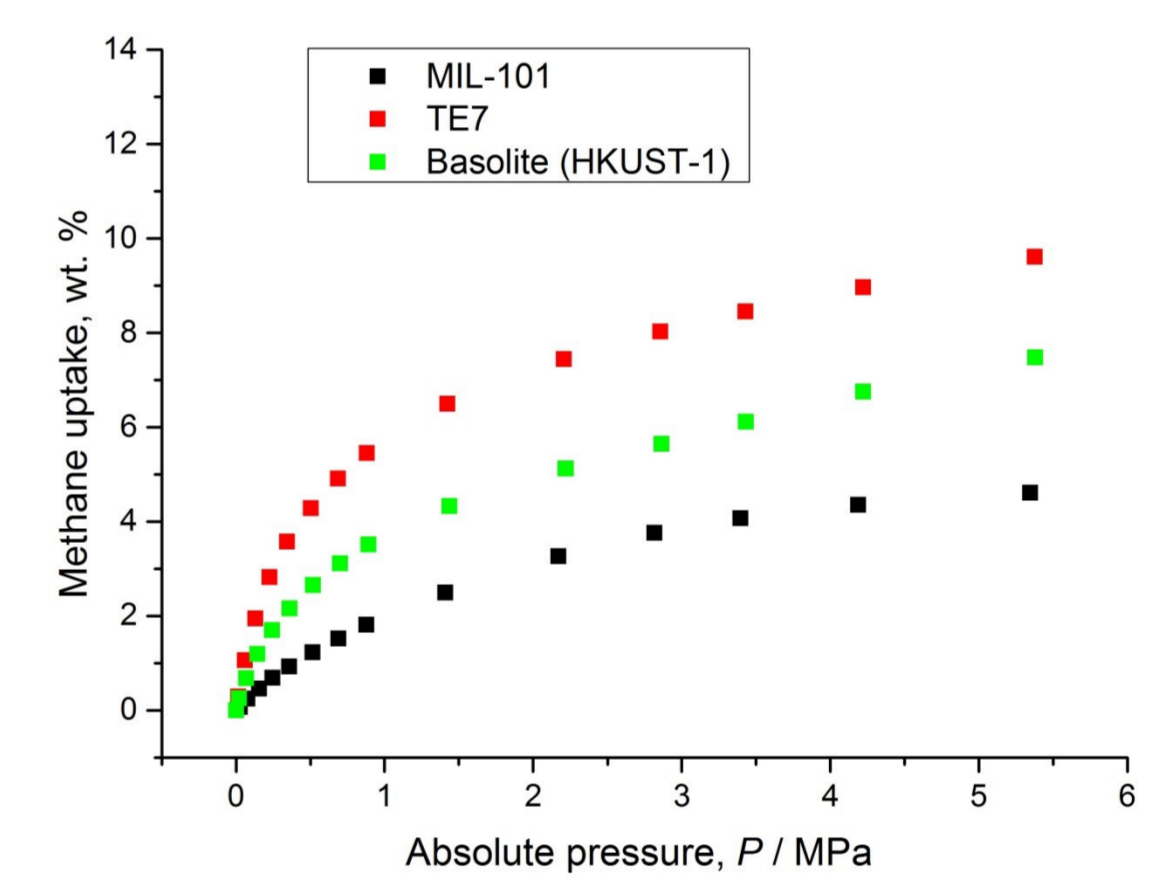
MIL-101(Cr) XRD and TGA

## Results

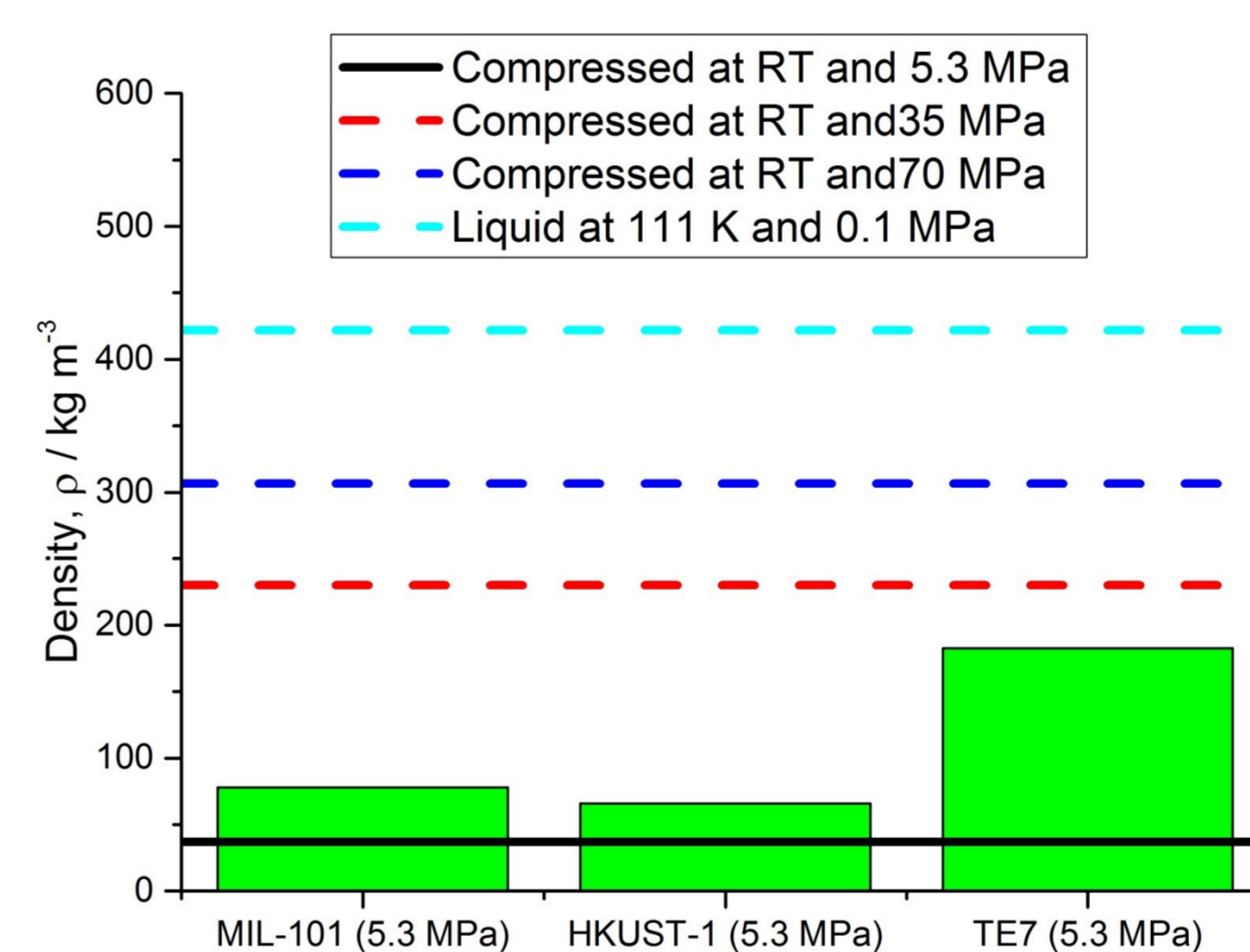
### High – pressure methane isotherms



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<sup>-3</sup>)

## Group



## References

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