



Lab-Tools Ltd.

Reg. Co. No. 510 1823
VAT No. GB- 849 4552 86

Lab-Tools are based at University of Kent's Canterbury Enterprise Hub, with research and analytic labs at Hersden:

We have in excess of 80 scientific publications in this field of porous media and liquids in confined geometry. For measuring pore size distributions, we find that NMR Cryoporometry is often the method of choice over other more established techniques.

Contact : Dr. Beau Webber

- **Honorary Research Fellow**, School of Physical Sciences, University of Kent, Canterbury, Kent. CT2 7NH
- **Honorary Research Fellow**, Institute of Petroleum Engineering, Heriot-Watt University. EH14 4AS
- **Director and Designer**, Lab-Tools Ltd., Canterbury Enterprise Hub, University of Kent, Canterbury, Kent. CT2 7NJ

Lab: 07544 915 464

Home: 01227 721 736

Mob: 07875 170 593

Fax: 01227 82 7778

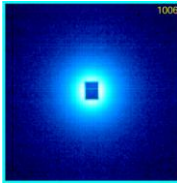
Email: J.B.W.Webber@kent.ac.uk

Email: beau@lab-tools.co.uk

Web: www.lab-tools.com

Web: www.nano-metrology.co.uk

Web: www.cryoporometry.com



Lab-Tools
<http://www.lab-tools.com>

NMR Cryoporometry

an analytic service

from

Lab-Tools Ltd.

***Science and Metrology
on the
nano- through meso- to micro-scale.***

NMR Cryoporometry is a novel pore size distribution measurement technique that we have developed at the University of Kent and at Lab-Tools Ltd.

NMR Cryoporometry is well suited to characterising structured matter on a scale of about 2nm to 2 μ m.

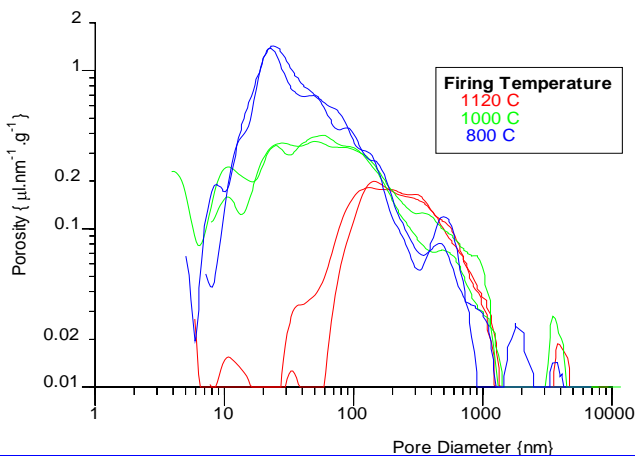
NMR Cryoporometry also measures particle size distribution and packing density, for densely packed particles.

Nuclear Magnetic Resonance Cryoporometry

J. Mitchell, J. Beau W. Webber and J.H. Strange. Physics Reports, 461, 1-36, 2008. [doi:10.1016/j.physrep.2008.02.001](https://doi.org/10.1016/j.physrep.2008.02.001)

NMR Cryoporometry offers the following advantages :

- The pore size calibration is in good co-linear agreement with gas adsorption measurements.
- NMR cryoporometry can measure over a wider pore size range than gas adsorption or thermoporosimetry.
- NMR cryoporometry can measure wet samples, and measures the true volume of pores for liquids.
- NMR cryoporometry measures a static signal; thus the measurement can be made arbitrarily slowly to improve signal-to-noise and resolution, whereas thermoporosimetry senses a transient, dynamic signal, limiting the resolution.
- NMR cryoporometry has no 'preferred' pore distribution curve, such as the Gaussian distributions often assumed by inversion techniques.
- NMR cryoporometry may be combined with standard NMR imaging techniques to perform non-destructive 1, 2 or 3 dimensional macroscopic spatial imaging of pore size distributions.



NMR Cryoporometry pore-size distributions :
A clay fired to three different temperatures -

Cryoporometry provides information that may be related to the durability and frost resistance of clays and clay mixtures.

NMR Cryoporometry measures pore volumes and pore size distributions on the 2nm to 2 μ m size range. It can also measure particle size distributions and packing, for densely packed particles.

Cryoporometry makes use of the fact that small crystals of a liquid in the pores melt at a lower temperature than the bulk liquid. This is the **Gibbs-Thomson effect**: *the melting point depression is inversely proportional to the pore size*.

A liquid is imbibed into the porous sample, the sample cooled until all the liquid is frozen, and then warmed slowly while measuring the quantity of the liquid that has melted.

Nuclear Magnetic Resonance (NMR) is used as a convenient method of measuring the quantity of liquid that has melted, deep inside the porous mass, as a function of temperature.

NMR Cryoporometry is, like gas adsorption, a thermodynamic method of measuring structure size. NMR Cryoporometry is closely related to thermoporosimetry, but has significant advantages. These techniques are all governed by the same set of Gibbs equations:

- Cryoporometry is the constant pressure case, and gas adsorption the constant temperature case;
- Cryoporometry uses the change between the solid and liquid phases of the imbibed liquid, and gas adsorption the change between the liquid and vapour phases.

