m-VROCi

EXTENDING INDUSTRIAL RHEOMETRY CAPABILITIES USING MICROFLUIDICS

RHEOLOGICAL PROPERTIES

- Accesses process-relevant flow conditions for low viscosity materials
- Ultra-high shear rates in excess of $1x10^6 s^{-1}$
- High sensitivity and high resolution viscosity measurements
- Proven rheometric principle on a microfluidic scale
- Robust data corrections for non-Newtonian materials
- Totally enclosed environment for highly volatile samples
- Use of small sample volumes for high value formulations
- Simplicity of operation with syringe loading
- All wetted materials highly chemically inert

Malvern Instruments m-VROCi utilizes innovative microfluidic 'Viscometer/Rheometer On a Chip' technology for extended rheometry measurement capabilities into flow regimes that are directly relevant to many industrial processes, but are inaccessible by traditional mechanical rheometry techniques.

m-VROCi can accurately measure low viscosity samples up to extremely high shear rates – critical conditions for the performance of inkjet inks in a print head, high speed coatings and sprays, application of personal care products, and lubrication processes.

m-VROCi provides high resolution measurements to discriminate small differences in viscosity in applications where viscosity is a critical performance parameter, such as electrolytes for rechargeable batteries and drink formulations.

The m-VROCi microfluidic rheometry principle provides high resolution viscosity measurements to ultra-high shear rates with small sample volumes

The rheometric principle of measuring shear stress in a rectangular slit to derive shear viscosity is well known – the m-VROCi is a microfluidic analogue of this configuration, and opens up unique measurement capabilities for relatively low viscosity materials.

Operating the m-VROCi involves loading a sample into a syringe and coupling it to a microfluidic flow cell. A high precision drive system pumps the sample at constant volumetric flow rate through a microscale channel, and integrated MEMS (micro-electro-mechanical system) sensors measure the pressure drop, which is proportional to viscosity.

Flow curves can be automatically generated, with full corrections for non-Newtonian behavior. The sample environment is totally enclosed, and highly volatile samples can be reliably measured over the full temperature range (4-65°C).

m-VROCi SPECIFICATIONS

m-VROCi system		Notes
Viscosity range[1]	0.3mPas – 100Pas	(1) Depending on m-VROCi flow cell type. Note that the maximum shear rate attainable is significantly reduced for high viscosity materials (see 'Shear rate range')
Viscosity measurement accuracy[2]	±2%	(2) For operating pressure >5% of full scale of flow cell
Repeatability[3]	±0.5%	(3) For operating pressure >10% of full scale of flow cell
Shear rate range[4]	$0.8s^{-1}$ – $1,400,000s^{-1}$	(4) Depending on m-VROCi flow cell type Indicative shear rate ranges (for a given viscosity) using a combination of standard flow cells and syringe sizes: $300s^{-1}$ to $1,400,000s^{-1}$ at 1mPas viscosity $30s^{-1}$ to $500,000s^{-1}$ at 10mPas viscosity $3s^{-1}$ to $50,000s^{-1}$ at 100mPas viscosity $1s^{-1}$ to $5,000s^{-1}$ at 1Pas viscosity $1s^{-1}$ to $500s^{-1}$ at 10Pas viscosity
Syringe sizes	0.5ml; 1.0ml; 10ml	
Minimum sample volume[5]	100µl	(5) Requires use of 0.5ml syringe and syringe jacket
Temperature range[6]	4°C – 65°C	(6) For the 0.5ml or 1.0ml syringes and thermal jackets, a maximum temperature of 68°C is achievable. For the 10ml syringe and thermal jacket, the maximum temperature limit is 65°C
Temperature accuracy	±0.1°C	
Temperature stability	±0.075°C	
Purge air supply[7]	20-40 scfh (10-20 slpm) at 5-10 psig; <1°C dew point	(7) Required for operation at measurement temperatures <18°C
Wetted materials	Borosilicate glass; silicon; PTFE; ETFE; PEEK; Au or Pt; Perlast® (perfluoroelastomer)	

m-VROCi flow cells		Notes
Standard range of flow cells[8,9]	(A05 flow cell) 50µm channel height; 10kPa full scale MEMS pressure sensors (B05 flow cell) 50µm channel height; 40kPa full scale MEMS pressure sensors (B20 flow cell) 200µm channel height; 40kPa full scale MEMS pressure sensors (C10 flow cell) 100µm channel height; 200kPa full scale MEMS pressure sensors (E05 flow cell) 50µm channel height; 2MPa full scale MEMS pressure sensors (E04 flow cell) 35µm channel height; 2MPa full scale MEMS pressure sensors	(8) Custom cells available on request (specify channel height and MEMS sensor full scale pressure reading) (9) For samples containing particulates - the maximum diameter of any particles in the sample must be <10% of the flow channel height

Malvern

Malvern Instruments Limited
Grovewood Road, Malvern,
Worcestershire, UK, WR14 1XZ

Tel +44 1684 892456
Fax +44 1684 892789

www.malvern.com

Malvern Instruments Worldwide
Sales and service centers in over 65 countries; for details visit:
www.malvern.com/contact

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