

## SphereMAG<sup>®</sup>

### High Quality Magnetic Polymer Microbeads

#### Background

Liquids Research Ltd is a world leading manufacturer of ferrofluids. We have used our particle production and dispersion technology to produce a range of magnetic polymer microbeads with average sizes from 0.1 $\mu$ m to 1 $\mu$ m. The initial ferrofluid is produced aggregate free by ultra-filtration giving a uniform particle loading in each bead.

The <1 $\mu$ m beads have a 50% weight magnetic loading. The 1 $\mu$ m beads having either a 40% or 60% loading. The magnetic loading is measured using a vibrating sample magnetometer rather than the iron content which gives an over estimate.

The level of surface functionalisation is comparable to or better than those of our competitors, determined via a titration method. The size range and distribution is measured via SEM. All products have been pasteurized and filtered.

Sedimentation is similar to or better than those of competitor products and gravitational stability is of the same order.

Our products are similar to competitor materials and effective for applications where COOH functionalisation is required. The degree of COOH functionalisation increases with greater magnetic content.

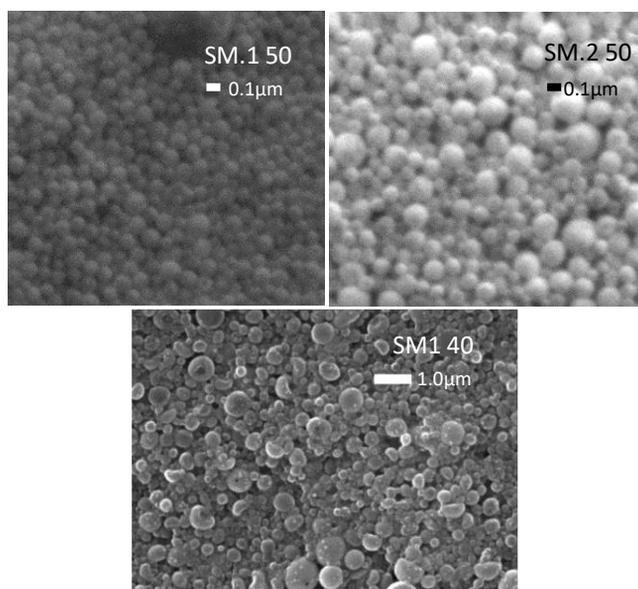
#### Quality Assurance

Production of SphereMAG<sup>®</sup> is carried out under ISO9001:2015 quality manufacturing procedures.

Each batch of SphereMAG<sup>®</sup> is individually characterised and supplied with a certificate of analysis (CoA) and a safety data sheet (SDS).

#### Sample Images

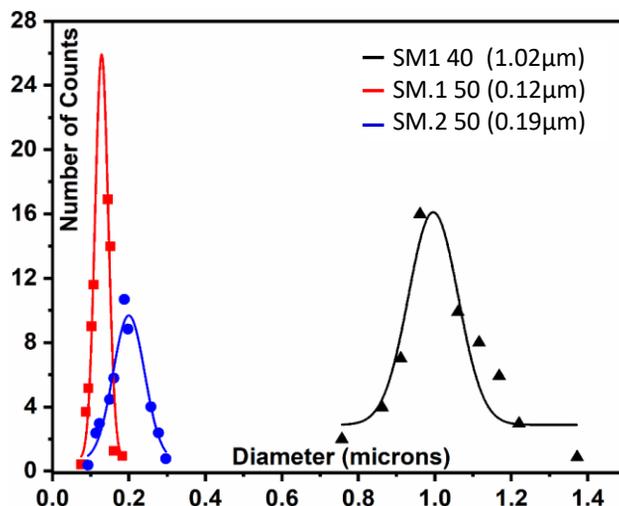
The images below were taken with a JEOL 7800 Prime SEM at a magnification of x30,000.



The beads are uniform with a size range within 30% of the mean. Mean values are determined over 100 beads taken randomly.

#### Size Distributions

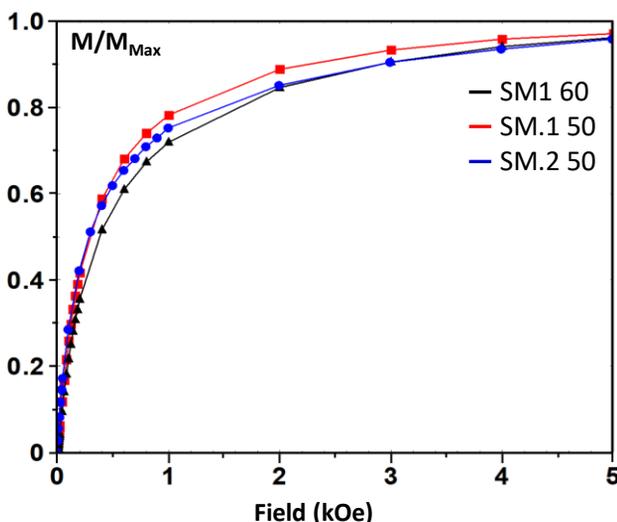
Polymer bead sizes were measured using a Zeiss Particle Size Analyser. Custom software was used to provide particle size and distribution.



## Magnetic Content Determination

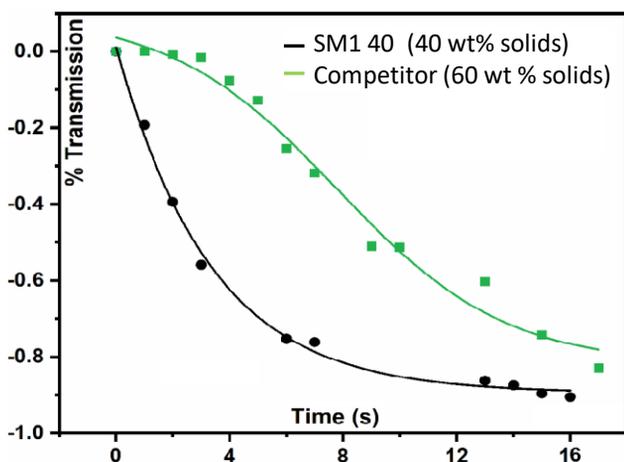
The magnetic content was measured using a Lakeshore Model 7400 series VSM calibrated against a Palladium standard. Samples of beads were dried at 80°C overnight and the magnetisation measured at a field of 9kOe (716 kA/m). This method is preferable to chemical analysis of the iron content as the surface atoms in nanoparticles are not magnetically ordered giving an of the magnetic content.

In the liquid state show that the beads are superparamagnetic following brief ultra sonification.



## Sedimentation Rates

Sedimentation was determined by light absorption. Samples were placed in a 10mm cuvette over an NdFeB magnet. The magnetic field gradient was 128 Oe/mm 20mm from the bottom of the cuvette.



## Surface Functionalisation

The level of surface functionalisation of carboxyl and amine is determined by conductometric titration. The beads are suspended in water, after being washed with 0.01M HCl to remove residual charged species. The particles are titrated against 0.01M NaOH. (Kong *et al*, Cent. Eur. J. Chem., 2008, 6(4), 627).

## Product Specifications

### Carboxyl Functionalised

Code	Mean Diameter	COOH Content (µeq/g) *	wt% Solids**	wt% Magnetic***
SM1 40C	1.0µm	150-200	10	40
SM1 60C	1.0µm	250-350	10	60
SM0.1 50C	0.1µm	100-200	10	50
SM0.2 50C	0.2µm	175-225	10	50

### Amine Functionalised

Code	Mean Diameter	NH <sub>2</sub> Content (µeq/g) *	wt% Solids**	wt% Magnetic***
SM1 60A	1.0µm	20 - 80	10	60

### Hydroxy Functionalised

Code	Mean Diameter	OH Content (µeq/g) *	wt% Solids**	wt% Magnetic***
SM1 60H	1.0µm	200-300	10	60

\* Measured µeq/g will be specified in individual certificates of analysis.

\*\* Total polymer bead content per ml of SphereMAG.

\*\*\* Average magnetite content per polymer bead.

## Pricing

### Carboxyl Functionalised

Code	1ml	5ml	≥10 ml
SM1 40C	€40	€30/ml	€20/ml
SM1 60C	€50	€40/ml	€30/ml
SM0.1 50C	€65	€55/ml	€40/ml
SM0.2 50C	€65	€55/ml	€40/ml

### Amine Functionalised

Code	1ml	5ml	≥10 ml
SM1 60A	€60	€45/ml	€35/ml

### Hydroxy Functionalised

Code	1ml	5ml	≥10 ml
SM1 60H	€60	€45/ml	€35/ml

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