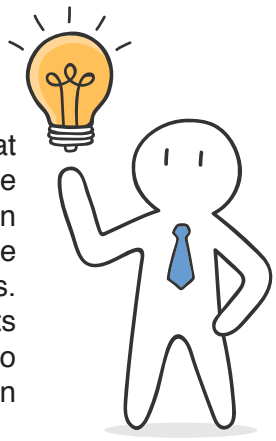
MagnoMeter XRS

Particle Suspension Characterization Analyzer - PSCA -

Mageleka

The *M*agno*M*eter XRS™ for Characterization of Particle Suspensions and Slurries



Over the years, material manufacturers have experienced that products can exhibit a performance problem that can not be explained from measurements using existing particle characterization tools. Subsequently, the issue was isolated to one critical fact: the measurement conditions are different from the application conditions. The *M*agno*M*eter XRS eliminates this problem because measurements can be made on the sample as it is formulated or manufactured and so the results obtained can be directly related to any associated application condition that is being monitored or investigated.

The *M*agno*M*eter is a next-generation particle analysis device that is an effective tool for:

- **Quality control of incoming raw materials**
- **Monitoring an intermediate stage manufacturing process**
- **Quality assurance of manufactured final products**
- **Rapid and easy assay to determine shelf life of inventories**

Particles can have the same size/shape but vastly different wettable surfaces

Increasing wetted surface area ---------->

Traditional particle sizing techniques, like laser diffraction for macroparticles and dynamic light scattering for nanoparticle characterization, normally assume that particles are spherical and smooth, but particles of most industrial materials are rarely either. Many optical spectroscopy-based instruments further assume that the composition of the particles under investigation are uniform and homogeneous, which may not be the case.

Therefore, the measured particle size (and also the calculated surface area value) based on these traditional techniques can be misleading, resulting in errors in its subsequent application and use.

The NMR technique used in the *M*agno*M*eter makes no assumptions about particle size or shape, and therefore can:

- **Easily differentiate two products that differ in surface area or shape but are the same in size**
- **Identify variations in the surface chemical composition of the same material**

What is the *M*agno*M*eter?

The *M*agno*M*eter is a new, next-generation, low-field nuclear magnetic resonance (NMR) spectrometer specifically designed to characterize particle suspensions using measurements of relaxation time. The NMR relaxation time is a fundamental, intrinsic, property of all states of matter, and the *M*agno*M*eter measures T_1 and T_2 relaxation times for both solid-liquid or liquid-liquid phase mixtures, and from as little as 0.01% to over 90% disperse phase concentration (sample dependent). From the relaxation times and their ratio, the effective wetted particle surface area – an important parameter for many applications – can be determined (by calibration) as well as optimizing dispersant and polymer adsorption concentration.

The *M*agno*M*eter is based on unique state-of-the-art Direct Digital Signaling electronics (patent pending) and:

- **Can measure industrial slurries and pastes directly without any dilution**
- **Is especially useful for nanoparticles, microemulsions and macromolecules**

Key Features*

- No moving parts, no optical alignment issues, no calibration required
- Simple plug-in set-up
- The temperature-controlled *M*agno*P*od™ is separate from the control module, which eliminates electronic and thermal interference
- 1 second – 2 minutes, real-time, fast measurement speed (sample dependent)
- *M*agno*P*od™ is ideal for hazardous sample isolation; multiple *M*agno*P*ods™ can be operated from one control module
- Unlimited non-invasive measurements with superior signal-to-noise ratio
- Exchangeable standard NMR glass sample tube to accommodate a very wide range of sample types
- Small footprint uses minimal bench space; limitless configurations of *M*agno*P*od™ and control module
- Provides a complimentary technique to traditional particle sizing, zeta potential, BET gas adsorption and mercury porosimtery analysis

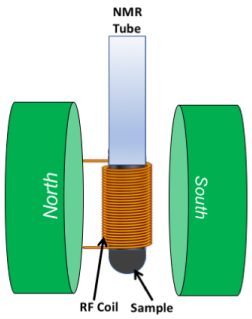
*Many upgradable features: please contact the manufacturer

How Does it Work?

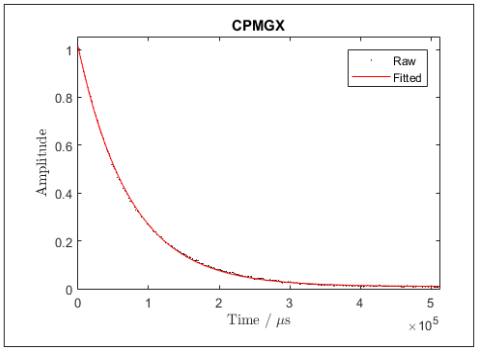
The sample to be tested is placed in a standard NMR tube and simply inserted into the *M*agno*M*eter, which has a built-in temperature controller for high consistency results.

The sample tube rests within a small coil located between two permanent magnets that create a uniform static magnetic field (see schematic) which aligns the proton spins within a liquid. A short duration magnet field is generated by a radio frequency (RF) pulse applied to the sample though the coil.

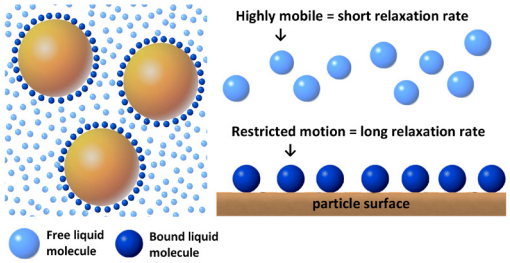
Magnet and RF Coil Assembly
The green discs are permanent magnets



This induces a temporary shift in the net orientation of the proton spins, dependent on the pulse length. Immediately after the pulse the proton spins of the sample fluid will then relax to realign with the static magnetic field. This induces a decaying voltage in the coil which can be precisely measured and from which a characteristic relaxation time can be derived. There are two distinct relaxation processes called T_1 and T_2.



The protons in any bulk liquid are highly mobile and have a long relaxation time, but liquid protons attached to the surface of any particles (i.e., those that "wet" them) have restricted motion, can interact magnetically with the surface, and therefore have a short relaxation time.

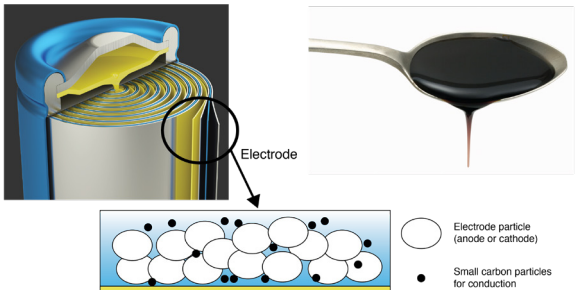


Schematic of bound and free liquid molecules and their relationships with NMR relaxation time. The relaxation rate is the inverse of the relaxation time.

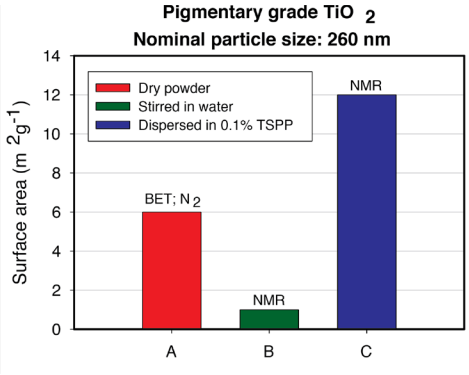
The T_1 and T_2 relaxation times are closely related to the interfacial properties of the particle surface and the specific dispersing liquid. Each time (T_1 or T_2) emphasizes a different characteristic behavior of the wetted particles. In any application – be it a clean or contaminated particle surface, a pure liquid, or a mixture – a different, but explicit (T_1 or T_2) relaxation time will be observed. The available wetted surface area of a dispersion can then be deduced from the relaxation times using a calibration procedure performed automatically by the *M*agno*M*eter.

Typical Applications

Batteries



Improvement in storage capacity, charge rate, and lifetime are common goals in battery development. A main challenge in advancing battery technology is to optimize the composition of the slurry mixture used to make the electrodes. Small particles provides a large surface area for better power production; large particles provides better electrolyte mobility for energy storage. In both cases, knowledge of the wetted surface area is essential.

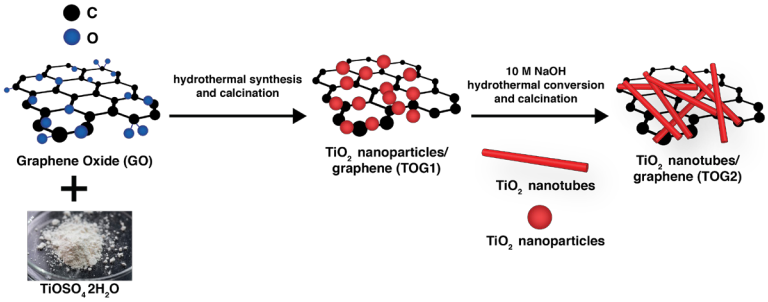


Currently, the particle surface area measurement is performed on dry powders with the assumption that the result can be related to the wet suspensions produced from them. However, any wetted surface area is critically dependent on the dispersion process used and, importantly, performance is directly related to dispersion quality. Further, suspensions invariably contain some fraction of aggregates or agglomerates – which reduce the effective surface area.

The *M*agno*M*eter can:

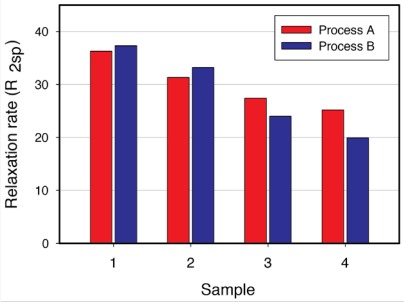
- **Directly monitor the wetted surface area of slurries at any concentration**
- **Utilize NMR relaxation technology that is is exquisitively sensitive to dispersion quality**

Graphenes



Because of its unique character, the oxidation state of graphene oxide (GO) can be tuned to make the material a semiconductor or insulator. GO is used in a

wide variety of industries including solar energy storage, conductive films, and biomaterials.



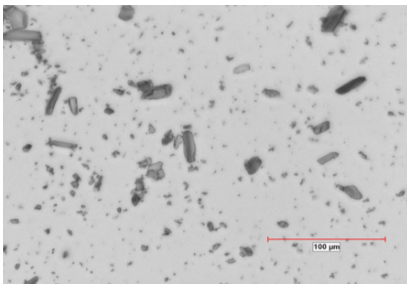
Large-scale manufacture is not a simple procedure, and management of the process is important because small variations can result in the final material having different structural properties. Hence, process reproducibility is of utmost concern. Many common particle characterization techniques require significant sample preparation for their measurements, but this changes the sample condition where it is being used, and is also time-consuming.

The *M*agno*M*eter:

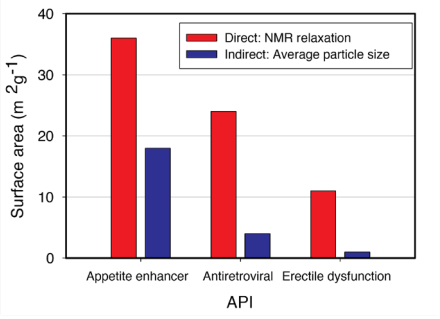
- **Does not require sample preparation for measurements**
- **Works with full-concentration industrial slurries**
- **Produces measurements that are very fast, non-invasive, and processing can be followed in almost real-time**
- **Utilizes a separate *M*agno*Pod* that can easily be adapted for on-line use**

Pharmaceuticals

In drug delivery it is the surface area-to-volume ratio, rather than the particle size, that primarily determines the adsorption efficiency of an active pharmaceutical ingredient (API). Precise quantification of API dissolution is also a key to toxicological control of the drug.



APIs are not round and smooth; particle surface irregularities and aggregate porosity impact the wetted surface area to a far greater degree than the measured particle size would suggest.



Calculation of a surface area based on the measured spherical equivalent particle size in a very dilute suspension is a coarse assumption and, further, necessitates a gross extrapolation to real-life use concentrations very often resulting in misleading conclusions.

The *M*agno*M*eter is designed to:

- Measure truly representative samples
- Help manufacturers get directly to relevant results within minutes
- Provide results that are pertinent to Quality by Design (QbD) methodology

Additional Applications

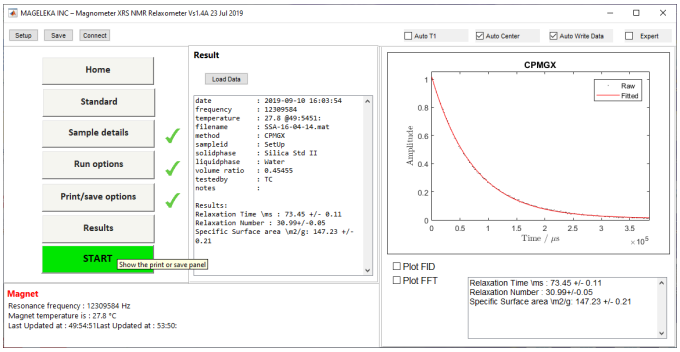
The *M*agno*M*eter is exceptionally versatile. Its use is almost unlimited. Applications range from Agrochemicals to Zeolites.

- Cellulose nanocrystals and paper pulp
- Ceramics, refractories and minerals
- Paints, inks, dyes and pigments
- MOF's and catalyst research
- Cosmetics and food emulsions
- Polymers and resins

Software

Industry Standard simple GUI layout with set-up button for automatic optimization of instrument

- Designed for use in R&D, QC/QA or Process manufacture
- Security and regulatory compliance
- Export to Excel for offline porcessing/archiving



Specifications

Relaxation Time: T_1 100 μs – 100 seconds, T_2 50 μs - 100 seconds
Concentration Range: 0.01% - 90% wt (sample dependent), no dilution required
Particle Size Range: 5 nm – 5 μm
Temperature Range: 4°C to 80°C
Sample Tube Size (I.D.): 2 mm – 8 mm
Sample Volume: 100 μL typical

Voltage: 100-240 VAC 50/60 Hz
Power: 120 Watts
Connectivity: Ethernet
Control Module: 360 x 255 135 mm (LxWxH); Weight: 6.3 kg
*M*agno*P*od™: 210 x 215 mm (H x Diam); Weight: 1.5 kg

Mageleka Inc.
1319 North New York Avenue
Winter Park, FL 32798, U.S.A.
Tel: (617) 331-1130
sales@mageleka.com
www.mageleka.com

Mageleka UK
Unit 17
Lea Green Business Park, Eurolink
St. Helens, WA9 4TR UK
Tel: +44 (0) 1744 325005
keith@mageleka.com