

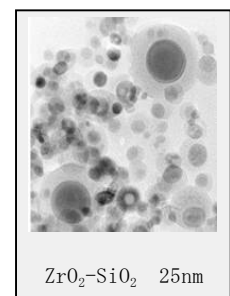
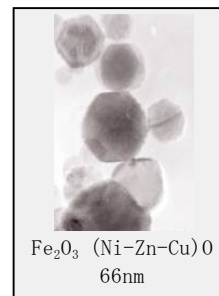
## HOSOKAWA NANOPOWDER TECHNOLOGY TO OPEN THE DOOR TO THE FUTURE

### Nanotechnology

Nanoparticles have huge potential across many industrial areas, particularly in electronics, information technologies and healthcare. Not only do they offer the attractive possibility of more effect for much less mass, but in many cases the product effect can be quite different from that achievable with micron sized particles, for example, their optical, mechanical, thermal and electrical properties show step changes at particular sub-micron particle size thresholds. Nanosized particles of various materials have a high potentiality to improve the performance of numerous kinds of products, or to create functional new materials. Their economic potential is therefore immense, although their advantages will need to be balanced against environmental effects which are in many cases still unknown.

Two generic approaches to the manufacture of nanoparticles are currently being pursued – “top-down” and “bottom-up”. Among the most promising “top-down” methods are ultrafine comminution, aerosol routes and very rapid precipitation. In the longer term, “bottom-up” molecular self-assembly routes are likely to become important commercially.

Current application areas for nanotechnologies are secondary battery production, fuel cells, magnetics, toners, engineering polymers, cosmetics, DDS (drug delivery systems), food, recycling, functional films, catalysts and electronic components (semi-conductors, condensers etc).



*Typical nano composite particles*

### New Technologies for functional Nanopowders

Through extensive research and development, Hosokawa has developed a new nanotechnology product portfolio featuring the latest product advances. The aim of Hosokawa has been to develop particle modification technologies which will increase customers' product values by improving and adding functionality.

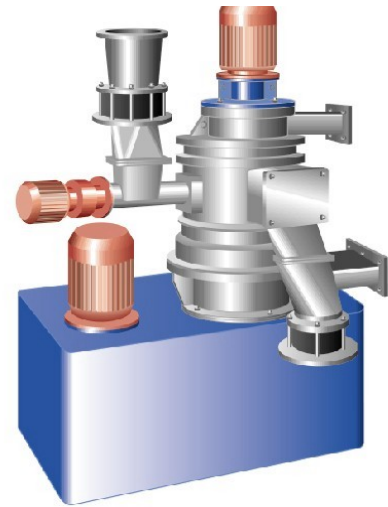
Current technologies available for the manufacture of functional nanopowders are dispersion, mixing (normal, ordered or precision), coating, fusion, reactions (solid-solid surface), Mechano Chemical Bonding (MCB), shape control, agglomeration, nanogrinding, drying from nanoslurries and the measurement techniques employed in evaluating these materials.

These technologies not only produce added value materials, but can also lead to process improvements by reducing process steps and energy costs.

The 'Faculty' is a new multifunctional processing unit for particle design and development, which combines mechanical treatment and separation, reducing process steps. Proven applications include dedusting and spheronisation of toner and increasing the bulk density of natural graphite.

The 'Mechanofusion' applies mechanically generated load to the material during processing, which precisely mixes different types of particles, not only producing composite materials but also controlling the formation of particle shape.

*Faculty Multi-processor*



*Nobilita*

The 'Nobilita' is another new multifunctional unit designed to perform high speed powder mixing combining particles into composites at high speeds.

Another addition to the range, the 'Nanocular' enables Mechano Chemical Bonding i.e. a solid particle bonding technology which utilises not only mechanical force, but an additional "third" energy such as plasma irradiation or high magnetic field to clean the particle surface, enabling it to form a strong bond with other materials. This new technology is available both as a laboratory size unit or production size system for continuous duty.

### **Nanogrinding**

Submicron and nanoparticles can be obtained in a "top-to-bottom" process by wet milling. Agitated media mills, such as the Hosokawa Alpine AHM mill are used to grind such particles with finenesses down to 10 nm. The process requires a high specific energy input, very small grinding beads and a high performance wear protection material. Particles have to be stabilised against re-agglomeration by use of chemical additives or an electrostatic or steric mechanism.

### **Measuring Particle Size**

Improvements in sample preparation processes require accurate measurement technologies that are fast, easy to use, and as far as possible, measure the material in its native environment. Before processing, particle interactions can be characterised by the Zeta potential. For submicron particle size measurement, laser diffraction, photo correlation, ultrasonic spectroscopy, centrifugal sedimentation or TEM image analysis can be applied. Recent light scattering technologies have moved a step towards this, with Malvern Instruments developing the new 'Zetasizer' Nano Series which can measure a combination of three of the most important parameters for the colloid and polymer chemist - particle size, zeta potential and molecular weight.

### **Downstream Processing**

Once nano sized materials are produced either in liquid or gas phase, elements of classical powder technologies are applied to further process materials. These processes can involve drying, blending or agglomeration of the particulates.

Other processing possibilities include high shear mixing and coating on the Hosokawa Cyclomix, fluid bed agglomeration using the Agglomaster or Hosokawa's latest development, stirred bulk freeze drying, designed to handle thermo-sensitive powders, fragile materials and ultrafine wet nanopowders.

### **Global Trends in Nanotechnology**

Nanotechnology is not only a crucial foundation for many scientific research projects, but can also cause changes in industrial structure and create wealth. The UK, USA, EU and Japan all have well-funded programmes for research in nanotechnology, including nanoparticles. In the UK the effort has been led by the "ACORN" (A Collaboration On Research into Nanoparticles) programme and MNT Initiative, supported by a wide range of industries, the Research Councils and the DTI.

The development of nanotechnology is closely related to today's economy filled with high-tech products in the 21<sup>st</sup> Century. Various innovations in the applications for nanomaterials have been realised, while many others are being developed. Various factors limit the commercial growth of nanomaterials and the development of nano products, the challenge continues to reach the promised land of Nanotechnology.