

**Advanced large-scale production of high-purity small-sized nanoparticles, dispersions,
ready for use nanoproducts with industrial applications**

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These days, the importance of nanotechnology is continuously increasing not only for the incredible future prospects, but also for current applications. Regarding this idea, solid projects in order to take advantage of the present possibilities will be the pillars for the next stage. Among all the synthesis techniques available, it is worth highlighting the advanced technology used in TECNAN (developed in L'UREDERRA Technological Centre) for a large-scale production of a wide variety of nanoparticles; resulting in extremely innovative nano-products with a very competitive price.

Nanoparticles of simple nano-oxides such as CeO₂, TiO₂ and ZnO have been synthesised by the pyrolytic dry-oxidation/pyrolysis of various precursors commercially available. This method is advantageous as many step processes of wet chemistry are not involved; resulting in high-purity nano-products after completing a process of outstanding simplicity. Furthermore, the procedure is environmentally friendly (the emission of nanoparticles into the air is carefully controlled) and no by-products are generated. The innovative process used in TECNAN starts solving the precursor in an organic solvent (e.g. toluene) under stirring in a reactor; this resulting solution is then exposed to pyrolysis in sophisticated equipment. Synthesised nano-powders are deposited in some filters and after several shakes the product is collected. Some details are confidential due to a patent.

Moreover, a detailed research has been made in order to achieve an appropriate methodology for industrial scale. The innovative technology developed enables high production rates, from grams to tonnes (lab. & industrial orders). In fact, when working at full capacity, a kilogram per hour can be obtained. For the obtaining of each nano-product, different specific procedure has been followed considering parameters such as solvent proportion, temperature, etc; based on the same method typology. Besides the basic production of those nano-oxides, the flexibility of the method makes possible new complex synthesis in such a large scale as well. Several variations are also being introduced in order to improve size-control and dispersity.

BET measurements were made to the described nanoproducts in order to obtain precise information related to the specific surface area of each material. In addition, the nanoparticles have also been characterised by TEM technique, showing relative/acceptable dispersity. The obtained nano-powders have soft colours (white, yellowish white...) and show great stability; they are packed in plastic bags and containers and stored in a warehouse at room temperature.

Another technical advantage that TECNAN has, is that TECNAN can produce complex and simple oxides with the same easiness, using the same procedure for both, with high quality

standards, high purity, stability at a very competitive price, in a flexible and environmentally friendly way, since no waste or by-products are generated. Production in only one step results in important savings in time, energy and cost. The flexibility of this methodology enables the preparation of a wide range of nanoproducts. TECNAN has 4 product range categories:

1- Nano-powders: Using advanced synthesis techniques, TECNAN produces and commercialises at industrial scale nano-oxides of more than 60 elements of the Periodic System in a clean and environmentally friendly way, obtaining products with high quality and purity, very small size (7-25 nm) and with multisectoral applications.

2- Dispersions: All the nano-powders produced by TECNAN are available dispersed in different media such as water, alcohols and other solvents, both in standard concentrations and in ad-hoc conditions according to the client's demands.

3- Tecnadis "ready for use nanoproducts": With its know-how in nanotechnology, TECNAN has developed a range of exclusive references based in advanced nanoparticle. These innovative products are completely ready to be applied directly on different substrates.

4- Masterbatches: TECNAN is highly skilled regarding incorporation of diverse nanofillers into polymeric matrices in order to obtain optimised properties for a broad spectrum of plastic materials such as polyethylene, both high and low density, polypropylene, EVA, rubber, etc.

TECNAN nanomaterials have applications in very different sectors, e.g. automotive catalysts, energy sector, construction of gas and pollutant sensors, photo-catalysts, electronic and photovoltaic materials, cosmetic, paint and varnish, etc. helping to establish TECNAN as one of the most competitive suppliers of these new materials worldwide.