**A FAST process and production system for high-throughput, highly flexible and cost-efficient volume production of miniaturised components made of a wide range of materials.**

# μ-FAST

## *NEWSLETTER. Issue Nr 1 – Powder ceramics & metals*

**Micro-FAST is a collaborative Research Project aimed to develop a completely new manufacturing system for the volume production of miniaturised components by simultaneous forming and electrical Fast sintering of advanced ceramic and metal micro-powders.**

**Examples of demonstration products targeted:**

**Left: Miniaturised cooling fluid turbine for EV range extender (DIAD-GROUP). Right: Piezo-based actuator (CEDRAT TECHNOLOGIES).**

**Supported by:**

***Highlights:***

1. **Hydrothermal synthesis technologies for powder sintering.**
2. **Nanostructured powder by high energy ball milling Technology.**
3. **Spray Drying for free flowing powder production.**

***Consortium Partners:***

***web site: www.microfast.eu***

## Hydrothermal synthesis technologies for powder sintering

**Obtaining high precision sintered ceramic parts with near net shape and controlled properties using field assisted sintering processes requires the development of nanostructured powders with controlled chemical and structural compositions and improved flowability.**

**In the frame of project 608720 MicroFAST, IMNR developed an innovative process to produce two types of nanostructured crystalline powders specially formulated for applications in micro-FAST sintering according to the end users' requirements. Integrating hydrothermal synthesis with spray drying in a continuous flowsheet was demonstrated at TRL 5.**

**Partially stabilized Zirconia doped with $Y_2O_3$ and $Mn_2O_3$ ("black zirconia") or $Ce_2O_3$ respectively ("yellow zirconia") synthesized via the hydrothermal-spray drying process have mean crystallite sizes in the range 20-30 nm and spherical particle with average particle sizes around 5 nm. The microFAST sintering of these nanopowders lead to sintered samples with very high densities (> 99.5% from the theoretical value) and are expected to be tested for application in ceramic stones for watches.**
**A similar process was used to obtain granulated lead zirconate powders (PZT) doped with La and Nb for piezoelectric applications.**

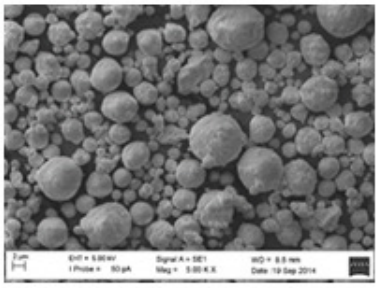

**Figure 1. SEM of Mn-doped partially stabilized zirconia**

**Figure 2. Ce-doped zirconia**

**For more information www.imnr.ro**

## Nanostructured powder by high energy ball milling technology

Different powder grades have been studied and produced by mechanical alloying for Micro-FAST process with the main purpose of developing processing procedure that enable to deliver material in the particle size range required by the process, with suitable nanostructure to facilitate the sintering and control of composition and purity of the material.

Titanium-Tin (Ti-Sn) material has been developed to achieve the full control of the microstructure of the powder (without presence of undesired intermetallic compounds) that allow to obtain sintered parts with very fine microstructure, low porosity and suitable properties for selected applications; stainless steel (AISI420) has been produced in a nanostructured version for Micro-FAST with suitable particle size distribution in the fine region (5 to 40 microns) with high efficiency of the mechanical alloying process.

Post treatment methodologies have been developed to achieved the particle size distribution required for the MicroFAST process and allow the complete handling of powder production under not oxidizing atmosphere: all powders have the requested flowability and can reach full density after the sintering process.

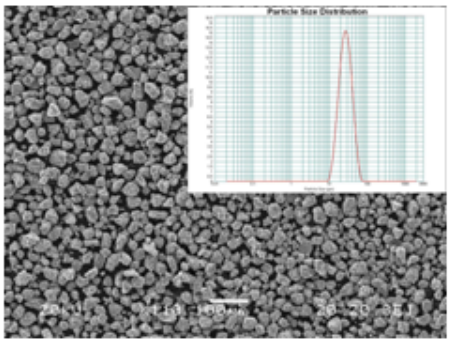


Figure 3.

For more information www.mbn.it

## Spray Drying for free flowing powder production

The focus of the Ceramic Materials and Powder Metallurgy group of VITO has been the development of free-flowing ceramic powders for the micro-FAST process. To this end, various granulation techniques were applied to transform commercial available materials such as MgO stabilized zirconia, alumina and silicon nitride into powders with spherical shape and a consistent particle size distribution suitable for the micro-FAST process.

The main technology used to achieve this objective has been spraydrying. In this process, a suspension containing the ceramic powders and organic additives is sprayed into the chamber giving droplets that are dried in heated air. Due to the rapid evaporation of water during the flight spherical granules are formed.

The focus has been to limit the amount of organics, while at the same time obtaining a stable and free-flowing powder which can be fed to the micro-FAST machine and that avoids dust formation.
In figure 4, the spraydryer used to prepare the free-flowing powders.

Figure 4.

Besides spraydrying, alternative suspension based granulation techiques, such as vibrational droplet coagulation and aerodynamicaly assisted jetting, were explored to prepare free-flowing powders. These allowed for more control resulting in very narrow size distributions of the granulated powder as well as an increased bulk density.

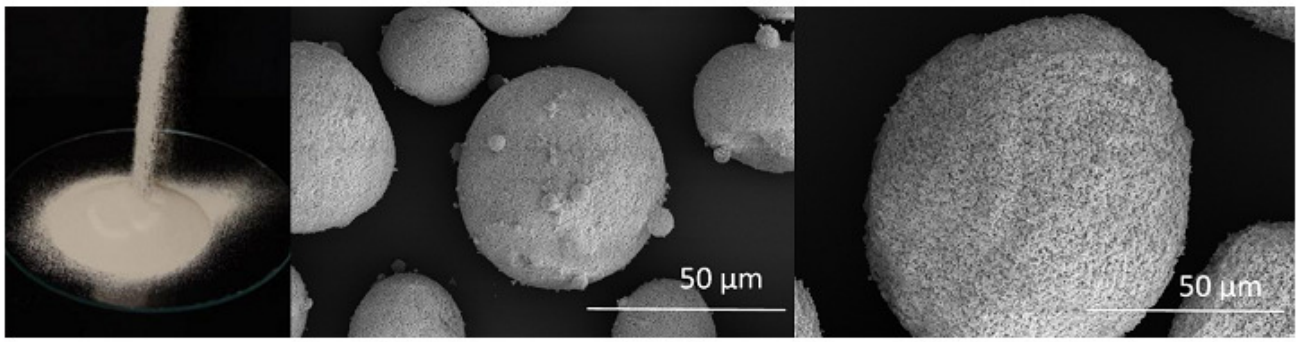


Figure 5: Free-flowing Mg stabilized Zirconia granulates prepared by spraydrying (middle) and vibrational droplet coagulation (right)

**Granulation gives the possibility to dope the powders with nano-particles of different compositions. This is done under controlled conditions in order to obtain a uniform distribution of the particles within the powder.**

**For more information www.vito.be or contact bart.michielsen@vito.be**