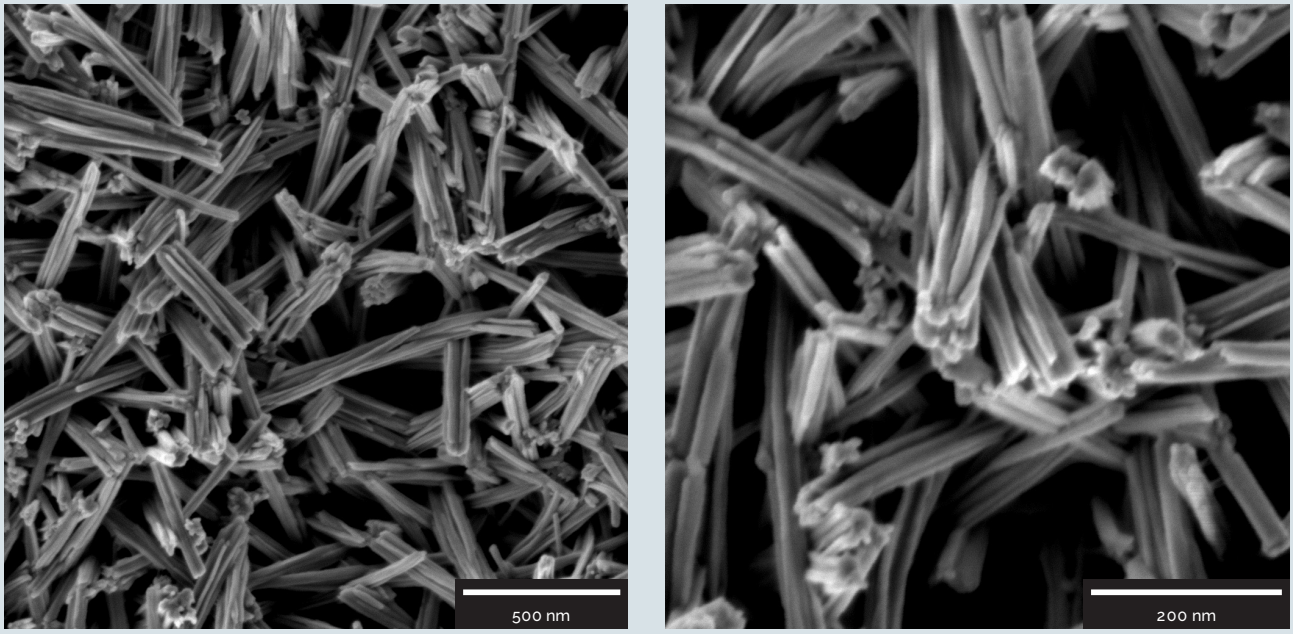
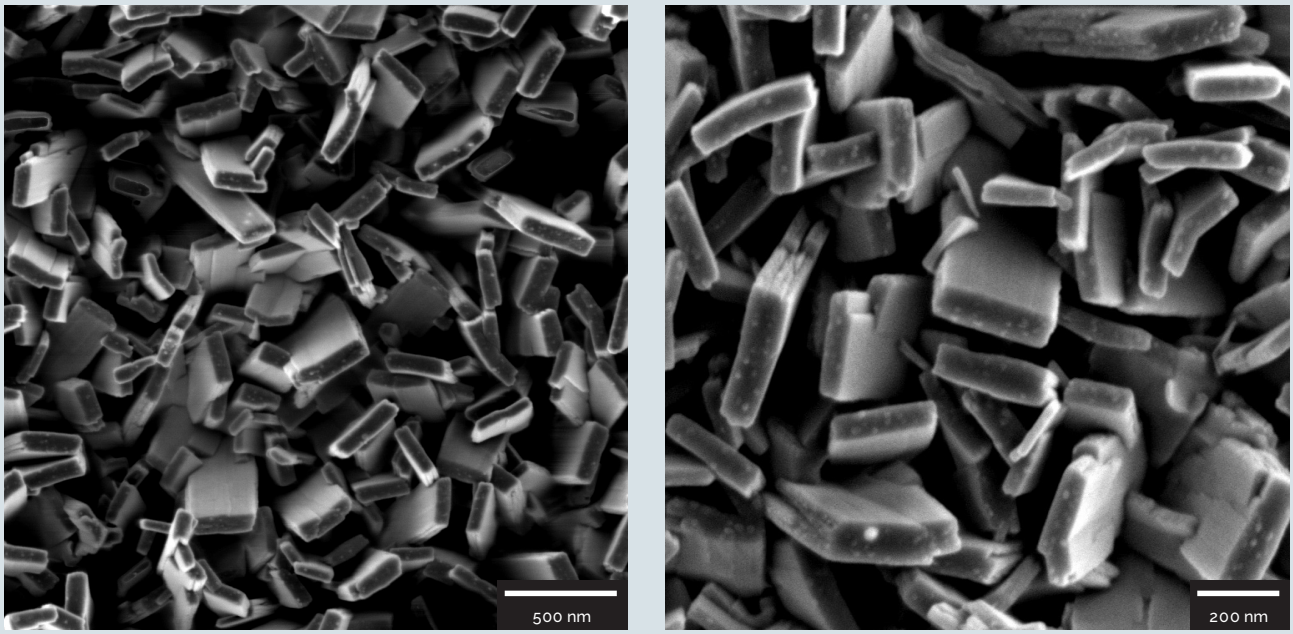
Analysis of ceramic nano-particles

Ceramic materials are used in a wide range of applications because of their diverse properties. In general, ceramics are considered as materials with great mechanical properties and high-temperature resistivity. However, ceramic materials also exhibit useful electrical, optical, and biological properties. The properties of ceramics strongly depend on chemical composition, crystallography and porosity. Hence, their applications spread through different fields ranging from grinding materials, bearings and disk brakes to coatings on jet engine turbine blades and biological implants.

Ceramics are produced from powder precursors that are subsequently heat-treated using a sintering process. The process of sintering is important and influences the final material properties. The final material properties are determined by the bulk material forming or shaping process and by the properties of the particles. The size and shape of the particles are the crucial parameters which must be considered when the material and its properties are designed. Therefore, the particles are a basic parameter affecting the bulk material. The size of the particles together with sintering temperature affects the final grain size and shape, thus this is important from the point of view of the material forming and pores creation. The size and shape of the particle is determined by the powder preparation process. Therefore, the synthesis of the particles is a very important step developing the new material.



c **Fig. 1, 2:** The particles of sodium nitrate crystals synthesized by hydrothermal treatment of titanium substrate in sodium hydroxide solution under nitrogen.



c **Fig. 3, 4:** Sodium oxide-nitrite crystals synthesized by hydrothermal treatment of titanium substrate in sodium hydroxide solution under nitrogen.

The size of ceramic powder particles can vary from micrometer size to nanoscale and can be different shapes from spherical to pellets, needles or cubes. What is important from the material science point of view is the particle size distribution, agglomeration forming, surface area of individual particles, chemical composition and in some particular cases the particle orientation in the bulk material as well. The methods for particle characterization are well established nowadays. Scanning Electron Microscopy (SEM) is an ideal tool to characterize and quantify the properties of ceramic materials. However, the analysis of ceramic particles requires the proper SEM because of the small size of the particles. To evaluate the surface of the particles conductive coatings are not recommended because the coating layer can obscure particle surface topography and material information. Therefore, imaging at low acceleration voltages is required. Low acceleration voltage is beneficial regarding the high surface sensitivity which can reveal the surface information more significantly. The Ultra High Resolution Scanning Electron Microscope (UHR-SEM) has become an ideal tool. The new TESCAN CLARA UHR-SEM with BrightBeam™ technologies delivers excellent low voltage imaging performance due to the combination of a full-column potential tube and combined electrostatic-magnetic objective lens. This system allows observation of samples in UHR without the need to immerse samples in a magnetic field. Therefore, the system has no restrictions regarding sample type. The potential tube inside the column provides improved beam parameters which leads to the better imaging capabilities. The particles of sodium nitrate crystals synthesized by hydrothermal treatment of titanium substrate in sodium hydroxide solution under nitrogen (Fig. 1, 2) and sodium oxide-nitrite crystals synthesized by hydrothermal treatment of titanium substrate in sodium hydroxide solution under nitrogen (Fig. 3, 4) were observed and analysed using the new TESCAN CLARA microscope.

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