Advanced Ceramics and their Composits For Energy Application

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Content

1 Introduction

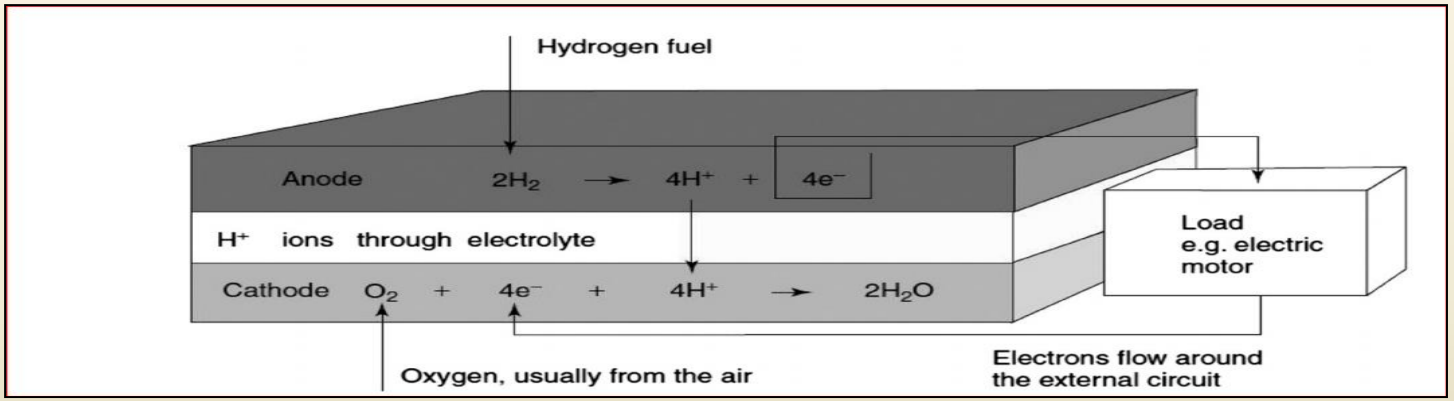
The high interest to investigate **Zirconia powder** and their composites is due to their extraordinary thermo-mechanical properties, in particular: high melting point, high mechanical properties, low thermal conductivity, and high ionic conductivity.

- Solid oxide fuel cells
- Supercapacitor materials
- Hydrogen storage
- Photovoltaic solar cells

Solid oxide fuel cells

Fuel cells are power generation devices that convert chemical energy of the reactants directly into electricity and heat with high efficiency and very low levels of poisonous emissions. SOFC operating at high temperature between 800 ºC to 1000 ºC are considered as one of the most efficient energy generator. Yttria-stabilized zirconia (YSZ) is the most frequently used material for SOFC electrolyte.

Operating principal of solid oxide fuel cells



The hydrogen and oxygen are recombining, and an electric current is produced along with the water obtained. The overall reaction is described in the following equation:

$$H_2(g) + 1/2O_2(g) = H_2O(l)$$

Supercapacitor materials

Supercapacitor batteries

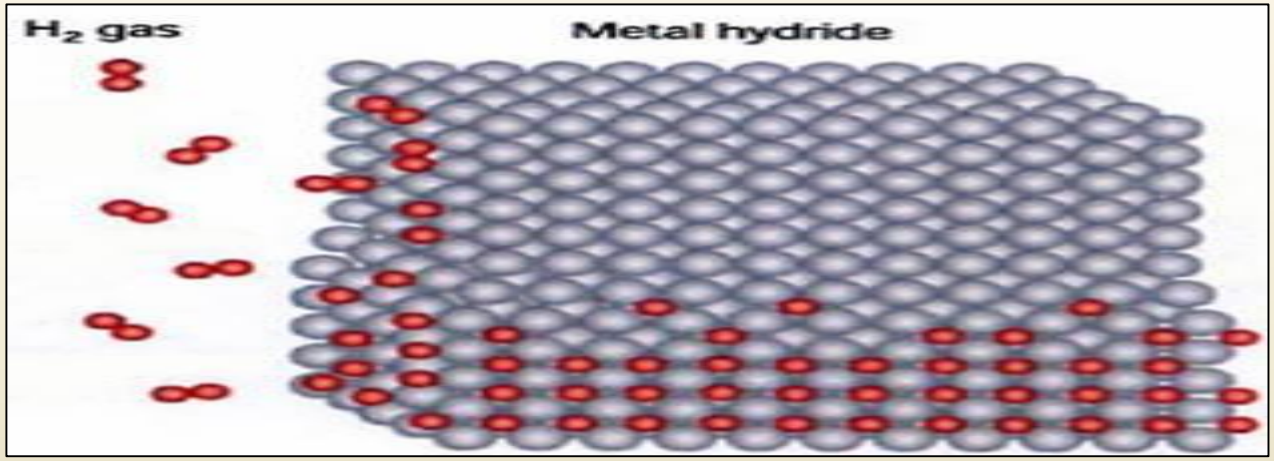
Carbon nanotube CNT, Graphen, paper, or Zirconia becomes widely employed for enhancing the mechanical and the electrochemical properties of supercapacitor materials.

Recently , many scientific research proved that the addition of Zirconia affect the morphological structure and increase the porosity of the electrodes , and thus leading to a remarkable enhancement in the capacitance .

Hydrogen storage materials

One of the most inovative method for hydrogen storage is based on thermochemical reactions that occur between the gaseous hydrogen and the solid materials mostly Metal hydrides .

Schematic view of Metal hydrides for hydrogen storage.



Using magnesium hydride with **zirconium oxide** and **single-walled carbon nanotubes** or magnesium hydride MgH_2, exhibit a high cyclic performance with significant reduction of the dehydrogenation and rehydrogenation temperature

Experimental work

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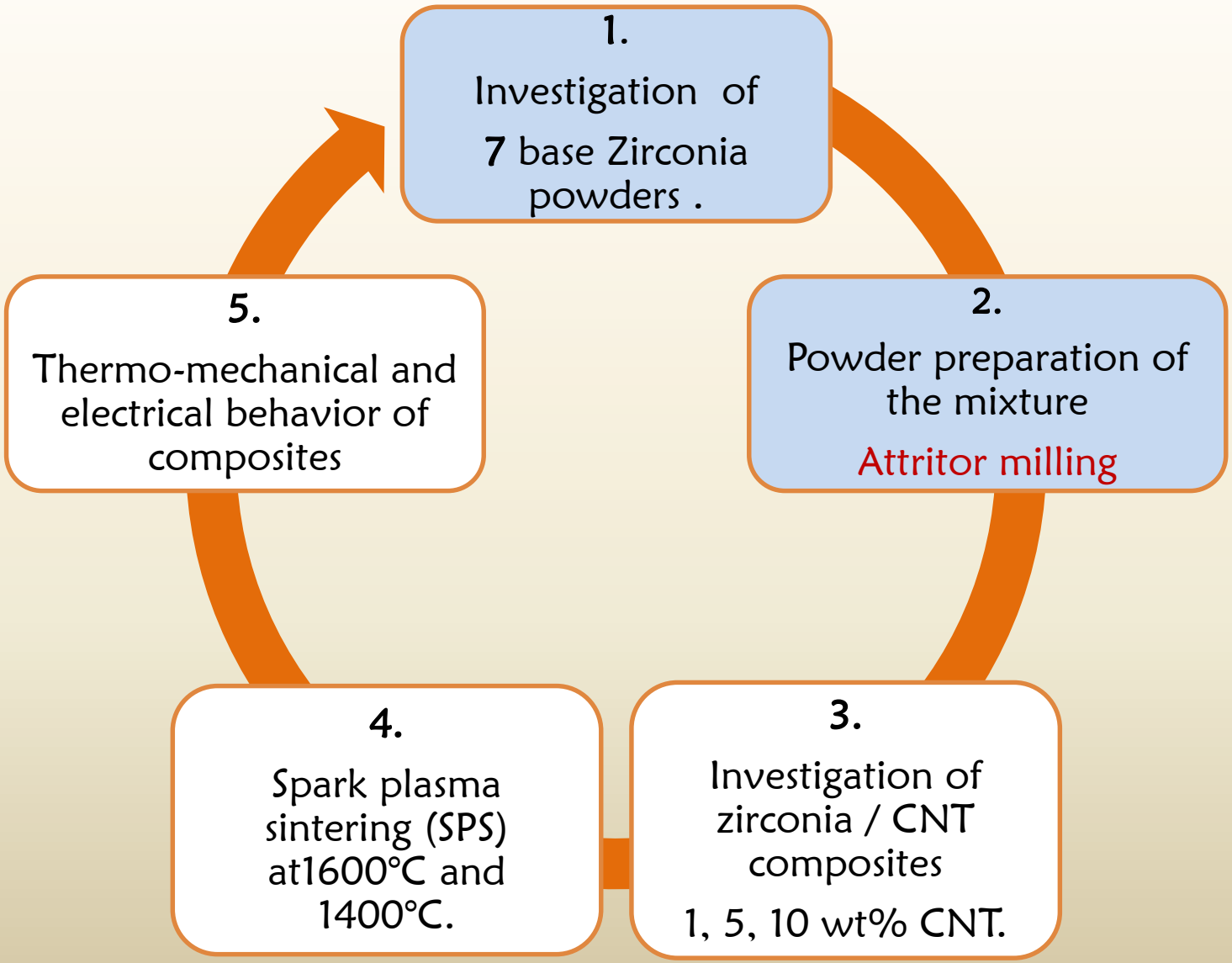
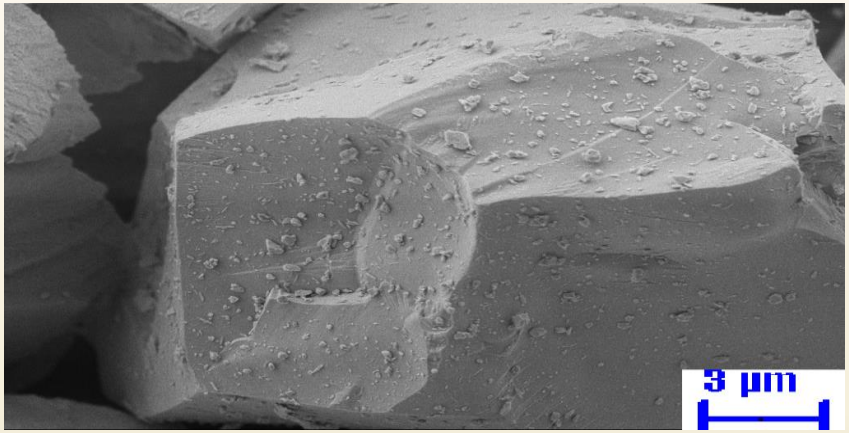
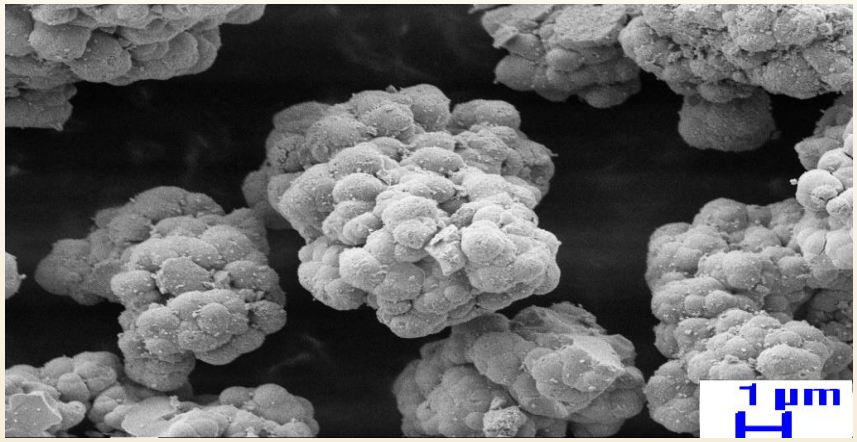


1. Investigation of base Zirconia powders

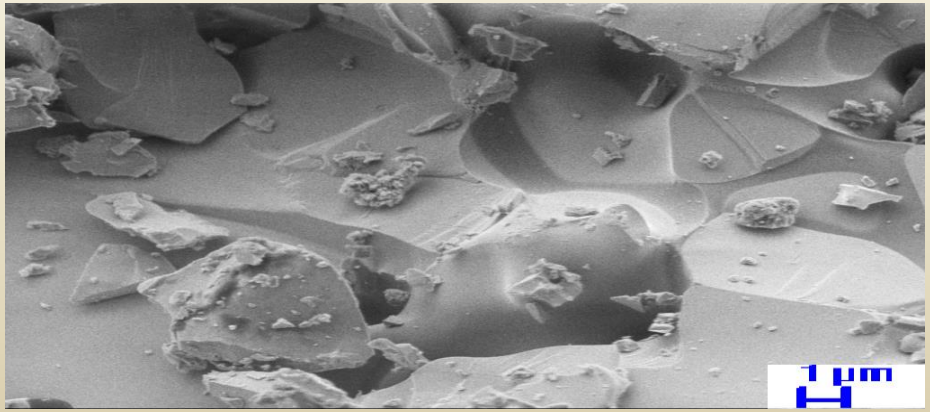
The powders shape was observed at low magnification 200X, Medium magnification,100KX and High magnification 500KX :



Irregular shape of Zirconia powder.



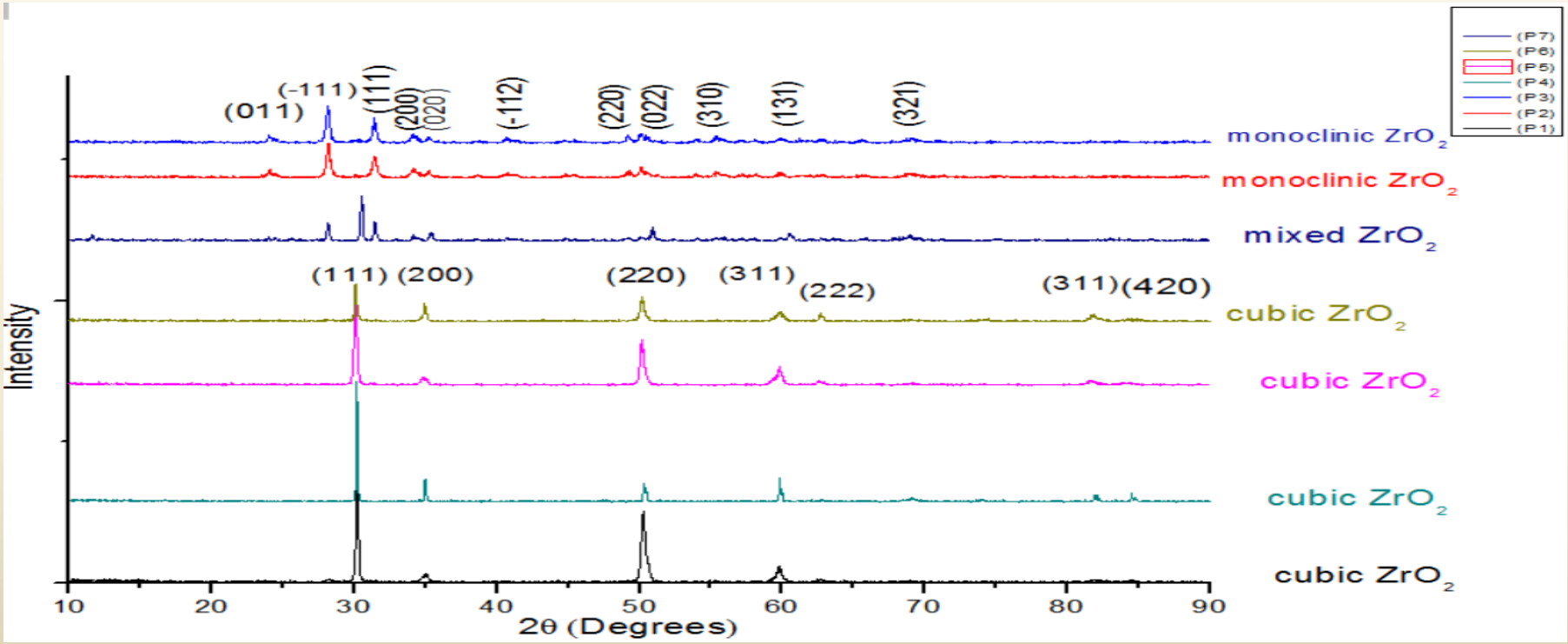
Agglomerated Zirconia powder .



Agglomerated and irregular shape of Zirconia .

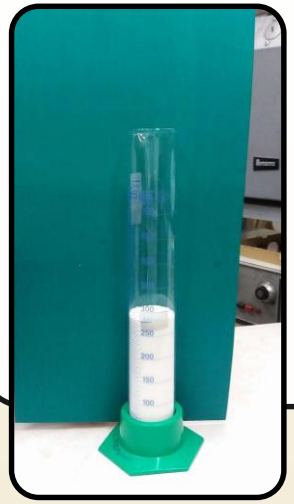
Agglomeration shape is due to the monoclinic phase, irregular shape refer to a cubic phase.

It was also observed that some Powders has a mixed phase which explain the morphological features shown by SEM between the agglomeration and irregularity of the powders shape.



XRD results of the seven zirconia powders before the mixture.

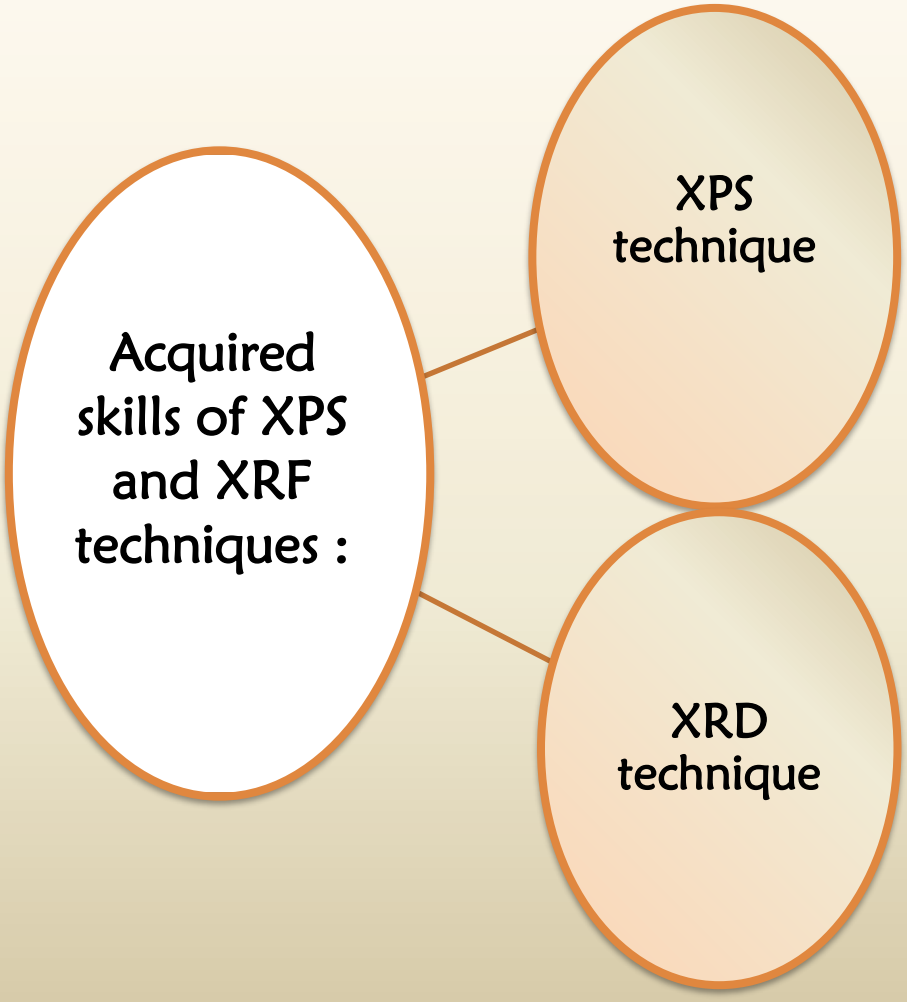
2. Preparation: Milling steps






280ml of zirconia balls (3mm diameter)	130 g of ethanol	Attritor mill at 4000 rpm for 5 h	Dring the powders at 172°C for 25 min	First sieving	Second sieving by 100 µm sieve

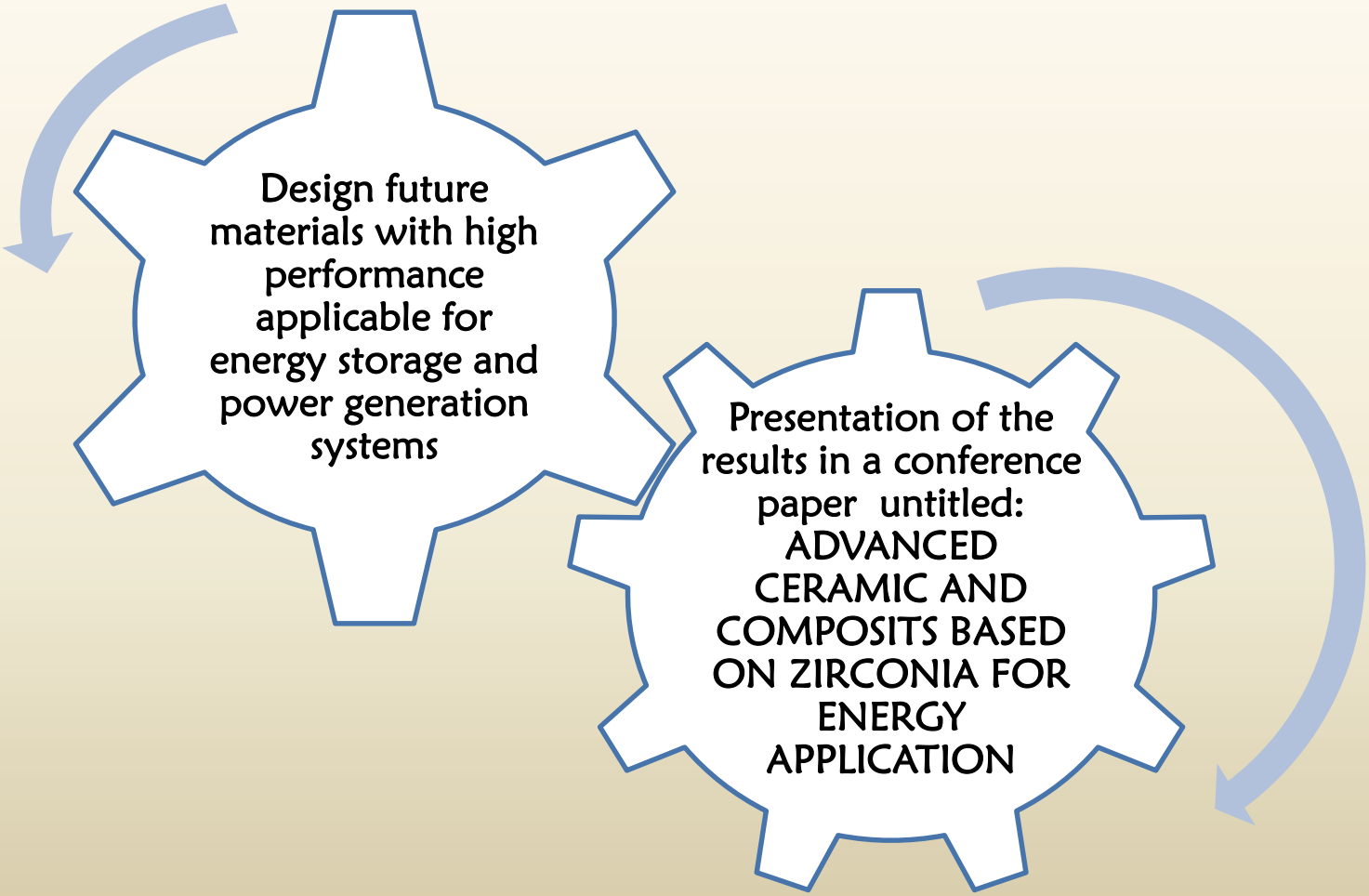
3 Courses



- Ability to determinate the elemental composition within the top 1-12nm of the sample.
- Determination of the Chemical state .
- Variation in incident photonenergy and the collection angle affect the depth and surface specifity.

- The X-rays emmited are characteristic of the atom and provide qualitative identification of the element.
- X-rays spectral lines are grouped in series (K, L, M) , all lines in a series result from electron transitions from various levels to the same shell.

4 Conclusion and perspectives



PLANS

- ECERS 2017, Budapest, 2017.07.9-13, poster presentation
- First publication with IF from preparation method of powders
- SPS Sintering of powders in ITU Istanbul
- Structural characterization of composites by TEM, HREM, SEM

Thank you for your attention!