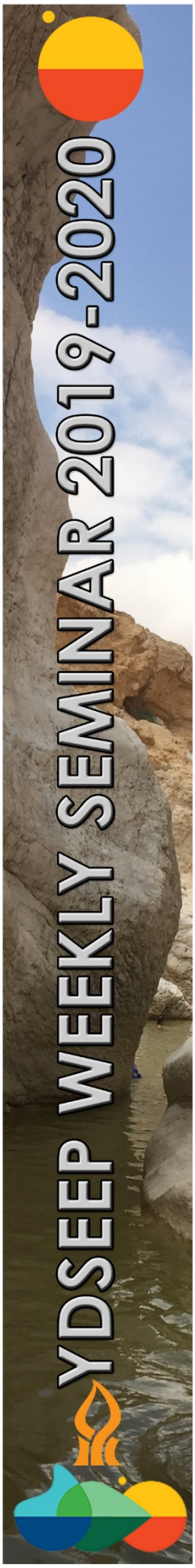


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# The development of novel nano metal oxide materials for solid oxide fuel cells applications

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Abstract:

State of the art materials currently used in most solid oxide fuel cells (SOFC) systems are yttria stabilized zirconia (YSZ) as the electrolyte which can be used either as 3YSZ ($ZrO_2$ doped with 3 mol% $Y_2O_3$) or 8YSZ ($ZrO_2$ doped with 8 mol% $Y_2O_3$). Although the ionic conductivity of 3YSZ is significantly lower, this material is advantageous because of its outstanding mechanical stability.

SOFC is an energy conversion device that produces electricity by an electrochemical reaction combining a fuel and an oxidant across an ionic conducting oxide electrolyte. Zirconia exists in three polymorphic modifications, these are monoclinic (M), tetragonal (T) and cubic (C). The consensus is that the crystal structure of YSZ varies from a monoclinic and tetragonal multiphase to a sole cubic symmetry when the $Y_2O_3$ content increases from 3 mol% up to 8 mol% .In literature however, there are many different and sometimes contradicting YSZ phase diagrams and for the nano YSZ system, there is no applicable accurate phase diagram especially at elevated temperatures. Regarding the mechanical properties of the YSZ electrolyte, it is reported that the tensile strength and bending strength of 3YSZ is much higher than 8YSZ. Therefore the 3YSZ is more commonly used in other applications such as thermal barrier coatings. We suggest investigating the intermediate compositions range of 3-8YSZ, in order to achieve a compromise between two contradicting demands: high ionic conductivity and improved mechanical properties by preserving the tetragonal character partially. It is important to note that the stability regions in the phase diagram of nano YSZ systems can be significantly different from those in bulk YSZ, and therefore YSZ sol-gel powder is worth investigating. The current research also correlates the YSZ sol-gel powder morphology as a function of the drying stage in the synthesis in the aim of producing nano internal voids in the powder particles. This morphology is in use in the energy field as solid oxide fuel cell's (SOFC) supports and thermal insulators, in environmental use as ceramic filters and as electrochemical sensors of monitoring NOx.

In addition, it was decided to investigate the crystal size effect in several other nano oxides ($Y_2O_3$, $Sm_2O_3$ and $Eu_2O_3$) which are used in various applications such as: in the energy field (solid oxide fuel cells, gas-turbine engines and thermal barrier coatings), in the medicine field (dental ceramic implants and coatings and in tissue engineering as scaffolds), optical (window and dome materials) and as phosphor materials and in catalysis. The results proved the role of crystals size in determining the obtained crystallographic phase and thus functionality.

## Date & Location:

**Tuesday, December 14, 2021, 11:00**
**Lecture Room – Physics building (entrance floor)**