



# Materials Research Laboratory

University of Nova Gorica, Slovenia



## ***X. Open Seminar Day of Materials Research Laboratory***

*Day: Monday, 13. 9. 2021*

*Venue: University Center Ajdovščina, Auditorium*

### **Program**

9:20 Intro:     *Matjaž Valant*

Session I - Chairman: *Mattia Fanetti*

9:30 - 9:50     **Saim Emin** – Growth of MoSe<sub>2</sub> electrocatalyst from metallic molybdenum nanoparticles for efficient hydrogen evolution

9:50 – 10:10     **Tina Škorjanc** – The synthesis and characterization of covalent extended structures for sensor applications

10:10 – 10:30     **Artem Badasyan** – Finite size effects and limits of Zimm-Bragg model

10:30 – 10:50     **Knarik Yeritsyan** – Some applications of polymer models

10:50 – 11:10     **Andreea Oarga Mulec** – Improvement and evaluation of technological applications towards sustainability inspired by natural processes

**Coffee break**

Session II - Chairman: *Luigi Giacomazzi*

11:40 – 12:10     **Invited talk; Igor Djerdj** (J.J. Strossmayer University of Osijek, Dept. of Chemistry, Croatia)  
Magnetic and electrical properties of selected nanocrystalline double and triple perovskites

12:10 – 12:30 **Sandra Gardonio** – Low energy electronic structure of Yb thin films

12:30 – 12:50 **Andraž Mavrič** – Stability of layered double hydroxides during electrochemical water oxidation

12:50 – 13:10 **Blaž Belec** – Silica coated Bi<sub>2</sub>Se<sub>3</sub> topological insulator nanoplatelets: alternative way to make them colloidally stable but perserving their optical properties

13:10- 13:30 **Matjaž Valant** – Starting points for the synthesis of “real” topological insulator

13:50 group photo and lunch

# Magnetic and electrical properties of selected nanocrystalline double and triple perovskites

Igor Djerdj

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Complex perovskites have attracted extensive attention due to their fascinating physical properties and novel features owing to the coexistence of the ferro/ferri-magnetic ground state and semiconducting behavior in the single material. The triple perovskite  $\text{Sr}_3\text{Co}_2\text{WO}_9$  (SCWO) has been successfully synthesized for the first time in the nanocrystalline form with an average crystallite size of 23 nm using a high yield (81 %) aqueous citrate sol-gel method [1]. The formation of SCWO triple perovskite was studied in situ by X-ray diffraction and subsequently analyzed by the Rietveld analysis. The detected hysteresis loops with non-zero remanent magnetization and rather large coercive field reveal ferrimagnetic ordering with a Curie temperature of 144 K. The Maxwell-Wagner model is employed to describe the frequency dependent dielectric constant. The frequency-dependent AC conductivity follows the universal Jonscher's power law. Double perovskites with  $\text{Sr}_2\text{NiMO}_6$ ,  $\text{Ba}_2\text{NiMO}_6$  ( $M = \text{Te}, \text{W}$ ) structure type have been similarly synthesized [2,3]. The reaction yielded phase pure nanocrystalline powders of two compounds  $\text{Sr}_2\text{NiWO}_6$  (SNWO) and  $\text{Sr}_2\text{NiTeO}_6$  (SNT0). Both SNT0 and SNWO possess high values of dielectric constants (341 and 308, respectively) with low dielectric loss (0.06 for SNWO) at frequency of 1 kHz. These values decrease exponentially with the increase of frequency to 1000 kHz, with dielectric constant being around 260 for both compounds and dielectric loss being 0.01 for SNWO and 0.04 for SNT0. The Nyquist plot for both samples confirms the non-Debye type of relaxation behavior and the dominance of shorter-range movement of charge carriers. Magnetic studies of both compounds revealed antiferromagnetic behavior with  $T_N$  being 57 K for SNWO and 35 K for SNT0. Since they possess both magnetic and semiconductor properties, these materials could be a promising candidates to use in devices where its semiconducting properties would be spin-controlled. One important example of complex perovskites utilization is in triboelectrification that is a trending and unique concept in energy scavenging methodologies with flexibility in choosing from a variety of materials. This paves the way to evolve eco-friendly triboelectric energy harvesters as a replacement for the limitation of batteries. The outstanding dielectric properties and low loss make triple perovskite a promising candidate for triboelectric nanogenerator (TENG), that can be used for sensing various gaits and information signalling (Morse code) in real-time applications, as well as for charging commercial capacitors [4].

These findings reported in this articles might show their significance in the near future in the development of self-powered information generator.

[1] Jelena Bijelić, Anamarija Stanković, Martina Medvidović-Kosanović, Berislav Marković, Pascal Cop, Yu Sun, Sugato Hajra, Manisha Sahu, Jelena Vukmirović, Dean Marković, Akos Kukovecz, Zvonko Jagličić, Bernd M. Smarsly, and Igor Djerdj, Rational Sol-Gel-Based Synthesis Design and Magnetic, Dielectric, and Optical Properties Study of Nanocrystalline  $\text{Sr}_3\text{Co}_2\text{WO}_9$  Triple Perovskite, *J. Phys. Chem. C* **124** 23, 12794-12807 (2020).

[2] Jelena Bijelić, Dalibor Tatar, Sugato Hajra, Manisha Sahu, Sang Jae Kim, Zvonko Jagličić and Igor Djerdj, Nanocrystalline Antiferromagnetic High- $\kappa$  Dielectric  $\text{Sr}_2\text{NiMO}_6$  ( $M = \text{Te}, \text{W}$ ) with Double Perovskite Structure Type, *Molecules*, **25** 17, 3996 (2020).

[3] Jelena Bijelić, Dalibor Tatar, Manisha Sahu, Zvonko Jagličić, Igor Djerdj, Size-Reduction Induced Properties Modifications of Antiferromagnetic Dielectric Nanocrystalline  $\text{Ba}_2\text{NiMO}_6$  ( $M = \text{W}, \text{Te}$ ) Double Perovskites, *Oxford Open Materials Science*, **1** 1 (2021), 1-9.

[4] Manisha Sahu, Sugato Hajra, Jelena Bijelic, Dongik OH, Igor Djerdj, Hoe Joon Kim, Triple Perovskites Based Triboelectric Nanogenerator: A Facile Method of Energy Harvesting and Self-Powered Information Generator, *Mater. Today Energy*, **20**, (2021) 100639.