The Serbian Society for Ceramic Materials
Institute for Multidisciplinary Research (IMSI), University of Belgrade
Institute of Physics, University of Belgrade
Center of Excellence for the Synthesis, Processing and Characterization of Materials for use in Extreme Conditions "CEXTREME LAB" - Institute of Nuclear Sciences "Vinča", University of Belgrade
Faculty of Mechanical Engineering, University of Belgrade
Center of Excellence for Green Technologies, Institute for Multidisciplinary Research, University of Belgrade
Faculty of Technology and Metallurgy, University of Belgrade

# PROGRAMME and the BOOK of ABSTRACTS

## 7CSCS-2023

**7th Conference of the Serbian Society for Ceramic Materials**
**June 14-16. 2023. Belgrade Serbia**

Edited by:
**Branko Matović**
**Jelena Maletaškić**
**Vladimir V. Srdić**

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# ENHANCED PROPERTIES OF PVDF COMPOSITES BY ACTIVE PHASE SILANIZATION

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$0.94[(Bi_{0.5}Na_{0.5})TiO_3]-0.06BaTiO_3$/polyvinylidene fluoride flexible composite films were prepared by the hot-pressing method. Surface modification of active phase particles was performed using two coupling agents, namely, (3-aminopropyl)triethoxysilane (APTES) and dodecyl triethoxysilane (DDTES) to enable good adhesion of active phase particles with the polymer matrix. The highest amount of electroactive PVDF β- phase was formed in APTES-modified samples while in DDTES samples mainly γ- phase was formed. Dielectric permittivity values and dielectric losses decreased for silanized samples due to reduced tension at the interface between particles and polymer. Strong intermolecular interaction between the PVDF chains and the APTES-modified particles led to enhanced breakdown strength of these samples. After the polarization of films, energy harvesting potential was evaluated for all samples. The highest voltage output of ~ 15 V and power ~ 225 μW were obtained for a single APTES-modified harvester [1-2].

1. M.M. Vijatovic Petrovic et al., *J. Alloy Compd.*, **884** (2021) 161071.
2. A.M. Chandran, et al., *Sustainable Energy Fuels*, **6** (2022) 1641

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# TWO-PHASE AND THREE-PHASE FLEXIBLE THICK FILMS: POTENTIAL USE AS ENERGY STORAGE AND ENERGY HARVESTING SYSTEMS

Jelena Bobić[1], Nikola Ilić[2], Zeljko Despotovic[3], Adis Dzunuzović[1], Robertas Grigalaitis[4], Ivan Stijepović[5], Mirjana Vijatović Petrović[1]

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For the last decades, energy harvesters based on piezoelectricity from mechanical vibration (wind, human activities, vibrations of machines and traffic, ocean waves, and acoustic waves) are explored extensively for its functionality in energy technologies. Typical applications that could benefit from mechanical energy harvesting are that many sensors, alarms, LED lights, and other low-power and ultra-low-power devices can be driven energetically completely independently [1]. To fabricate a flexible piezoelectric energy harvester (FPEHs) that operates under various conditions, ceramic particles were blended with a polymer to form composite films.

Two-phase lead-free $BaZr_{0.2}Ti_{0.8}$/PVDF and lead-based $PbZr_{0.52}Ti_{0.48}$/PVDF piezocomposites, as well as three-phase $PbZr_{0.52}Ti_{0.48}/Ni_{0.7}Zn_{0.3}Fe_2O_4$/PVDF composites films with variable filler content (up to 50 vol.%) have been prepared by hot pressing method. Structure and morphology of piezo-active phase powders as well as distribution of filler in obtained flexible films were characterized by XRD and SEM analysis. Total amount of electroactive phase (% $F_{EA}$) of PVDF in all films were investigated by FTIR analysis. In all composites dielectric permittivities was increased in contrast to their polymer PVDF host matrix, but also displayed decreased breakdown strength and raised energy loss. In addition, the remnant polarization (*Pr*) and leakage current were also investigated to evaluate the breakdown strength in all types of flexible films. Also, ferromagnetic response was established in PZT/ferrite/PVDF films under magnetic field of 10 kOe.

Calculations of storage energies and output voltage obtained for the investigated materials revealed an increasing trend with increasing amount of active phase. The maximum storage energy of 0.42 $J/cm^3$ at 390 $kV/cm^3$ was obtained for PZT-PVDF (40-60) films while the maximum output voltage of about 10 V was obtained for PZT-PVDF (50-50) flexible film. In addition, comparisons between properties of

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