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XVI МІЖНАРОДНА КОНФЕРЕНЦІЯ З ФІЗИКИ І ТЕХНОЛОГІЇ ТОНКИХ ПЛІВОК ТА НАНОСИСТЕМ

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(dedicated to memory Professor Dmytro Freik)

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Y-doped $BaTiO_3$ Ceramics with Mn Additives as Ferroelectric-Semiconductor with Nanosize Inner Interfaces

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Ferroelectric-semiconductor polycrystalline structures with nanosize inner interfaces attract interest due to their high (colossal) permittivity ($\varepsilon > 1000$) offering promising opportunities in the development of high-energy-density storage devices. It is known that the semiconducting grains and insulating nano-thick grain boundaries of the ceramic samples contribute to their colossal permittivity which can be used for instance in the internal barrier layer capacitors (IBLCs). The colossal permittivity is the characteristic of $BaTiO_3$-based ceramics, and can be explained by internal barrier layer capacitance [1], hopping polarization [2], and external barrier between electrode and ceramics [3]. The present work is devoted to a deeper understanding of the nature of colossal permittivity of $BaTiO_3$-based ceramics with the view of its further enhancement.

Polycrystalline Y-doped $BaTiO_3$-based solid solutions with different amount of Mn additives have been synthesized using a solid-state reaction technique. Structural and electrical properties of the samples have been studied in details to understand the impact of different polarization mechanisms in the total value of permittivity. All of the samples demonstrated single-phase composition, and tetragonal symmetry at room temperature. It has been found that relatively high permittivity ($\sim 10^4$) of the ferroelectric-semiconductor solid solutions based on barium titanate can be achieved over the wide range of measurement temperatures. However, the dielectric losses of the materials with colossal ε values are too high enough to limit their potential applications. Impedance spectroscopy shows that the impact of various polarization mechanisms to the permittivity decreases in the range: “internal barrier layer capacitance → external barrier between electrode and ceramic → hopping polarization → spontaneous ferroelectric polarization”.

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