$0.7Pb(Mg_{1/3}Nb_{2/3})O_3$-$0.3PbTiO_3$ (PMN-0.3PT keramini sluoksniai pagaminti tepimo metodu

$0.7Pb(Mg_{1/3}Nb_{2/3})O_3$-$0.3PbTiO_3$ (PMN-0.3PT) ceramic films prepared by tape casting method

Tomas Kudrevičius[1], Artyom Plyushch[1,2], Maksim Ivanov[1],·Šarūnas Svirskas[1],
Valentina Plaušinaitienė[3],·Algirdas Selskis[4], Polina Kuzhir[5,2], Jūras Banys[1]
[1]Faculty of Physics, Vilnius University, Sauletekio 9, Vilnius LT-10222, Lithuania
[2]Institute for Nuclear Problems of Belarusian State University, Bobruiskaya 11, Minsk 220030, Belarus
[3]Department Inorganic Chemistry, Vilnius University, Naugarduko 24, Vilnius LT-03225, Lithuania
[4]Center for Physical Sciences and Technology, Sauletekio 3, Vilnius LT-10257, Lithuania
[5]Institute of Photonics, University of Eastern Finland, Yliopistokatu 7, FI-80101 Joensuu, Finland
artyom.plyushch@ff.vu.lt

Tape casting is one of the most popular wet-shaping manufacturing technologies of ceramic films in large areas. It is one of the main ferroelectric film manufacturing technologies. Wide range of the applications of the ferroelectrics includes multilayered capacitors and energy storage, biomaterials, piezoelectric actuators or sensors. Non-aqueous tape casting requires different organics like alcohols, ketones, oils as a solvent. Despite short evaporation time, these liquids have environmental and safety issues. An aqueous tape casting is the eco-friendly alternative. The works devoted to waterbased tape casting of the ferroelectrics are still rare [1,2].

Commercially available by American Elements PMN-0.3PT powder was used for the preparation of the films. A solution of an ammonium salt of an acrylic polymer in water, Dispex AA4040 (BASF) was used as a surfactant. Luvitec K 90 powder by BASF, a water-soluble polyvinylpyrrolidone (PVP) was used as a binder. Both binder and surfactant are eco-friendly polymers.

Several suspensions were tested for the determination of the optimal concentration of surfactant (see Fig. 1). The dependences of the viscosity versus shear rate and surfactant loading demonstrate, that the minimal μ is achieved with the surfactant content of 0.46 g, or 0.0137 g per 1 gram of solid content (highlighted with arrow). The solid PVP binder was dissolved directly in the slurry, and after mixing and defoaming, the obtained suspensions were cast using the homemade doctor blade technique. The doctor blade height was 0.25 mm. Two series of samples were prepared. The first series made with variable binder loading and a fixed water/solids ratio of 19 wt. %. The second made with a fixed binder/solids ratio of 1.37 wt. % and variable water content.

It was shown, that the density of the calcined films depends on the binder amount and does not depend on the water content and reaches up to 98 % for the sample with minimal binder loading. As a result, highly dense (up to 98 %) translucent ceramic films with thickness down to 70 μm (see Fig. 2) are prepared. The dielectric permittivity, polarization and pyroelectric coefficient of the ceramic films are investigated. Above room temperature, the sample undergoes two phase transitions at 100 and 175ºC. The dielectric permittivity and polarisation are high in comparison to the ceramics, synthesized using other methods (spark plasma sintering, uniaxial pressing.

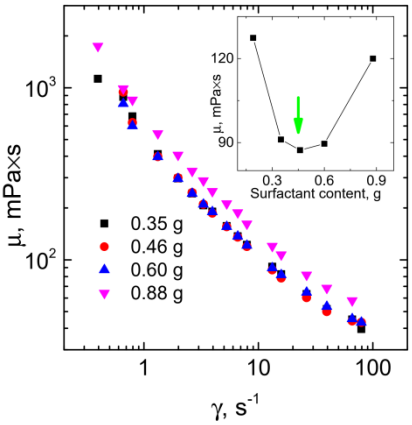

Fig 1. Viscosity of the slurries with different surfactant content *vs* the shear rate. Inset: the comparison of the viscosities at the shear rate of $\gamma = 13.2\ s^{-1}$.

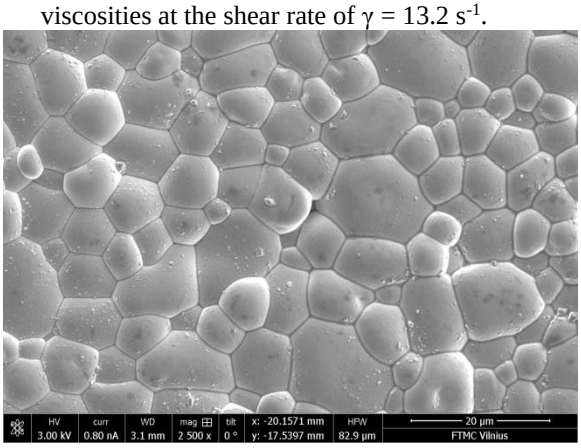

Fig 2. Scanning electron microscopy of the calcined ceramics with the density of 98 %

Keywords: Tape casting, PMN-PT, dielectric properties, ferroelectric properties.

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