P59

A technique of creating of ferroelectric regular domain structures using highly dissipative liquids at room temperature

V.V. Krutov, A.S. Sigov, A.A. Shchuka

MIREA – Russian technological University, Moscow, 119454 Russia
v_krutov@mirea.ru

A number of applications of ferroelectric regular domain structures (RDS) as photonic and phonon crystals are known. Recently, Chinese scientists have found a new application of ferroelectric RDS as actuators with improved characteristics. The authors of the article [1] presented an actuator (with a giant deformation) based on RDS in PZT ceramics, as well as its multilayer modification [2].

At the same time, at the present stage of development it is not enough to develop devices and technologies, focusing only on the physical aspects of solving the problem, and it is advisable to go to the most economical technological solution, reducing the duration of the technological cycle, which is especially important in the mass production of products. In this regard, it is promising we develop "double pulse heterothermal" technique with extremely short duration of the technological cycle among peers [3-5]. It should be noted that in contrast to existing methods using standard equipment, a completely new technique is being developed that requires the use of electroacoustic modules with interfering (at a given angle) ultrasonic beams.

The report is devoted to the phenomenon of RDS formation in ferroelectrics under the action of a uniform electric field and a temperature lattice induced by interfering elastic waves. The possibilities of creating ferroelectric RDS with a period $d \approx 40\text{-}100$ μm using ultrasonic waves at frequencies close to the lower boundary of the microwave range ($f \approx 300$ MHz) are considered with the help of computer modeling. Such RDS are used, for example, in acoustoelectronics in the manufacture of acoustic filters and resonators with improved characteristics, as well as generators of terahertz waves [6]. The model describes the effect of interfering ultrasonic waves on the ferroelectric through a thin layer of a liquid electrode with a thickness δ less than half a period of the formed domain structure. Efficiency of use as liquid electrodes of electrically conductive liquids with a high value of the *A* coefficient of the frequency dependence of the absorption index $\alpha = A f^2$ in the specified frequency range was shown. The results of estimation calculations of the main technological parameters for liquid electrodes based on ionic liquids with a high *A* coefficient are presented.

It was shown, that the use of highly dissipative ionic liquids such as 1-butyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide (the synonym is [$\mathbf{C_4}$mim][NTf_2]) and 1-hexyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide (the synonym is [$\mathbf{C_6}$mim][NTf_2]) creates favorable conditions for the application of the technique at room temperature.

A low acoustic loss material with isotropic properties (fused quartz) is used in the model. Recommendations on the choice of ultrasound frequency and angles of incidence on the quartz-liquid interface providing necessary spatial period of RDS are given. The work was supported by RFBR (grant 19-07-00469).

1. F. Li, Q. Wang, H. Miao, *J. Appl. Phys.* **122**, 074103 (2017).
2. Q. Wang, F. Li, *Sensors and Actuators A: Physical* **272**, 212 (2018).
3. V.V. Krutov, A.S. Sigov, A.A. Shchuka, *Ferroelectrics* **476**, 69 (2015).
4. V.V. Krutov, V.G. Mikhalevich, A.S. Sigov, A.A. Shchuka, E.A. Zasovin, *Phys. Solid State* **54**, 965 (2012).
5. V.V. Krutov, A.S. Sigov, A.A. Shchuka, *Applied Physics* **3**, 53 (2018).
6. G.Kh. Kitaeva, S.P. Kovalev, I.I. Naumova, A.N. Tuchak, P.V. Yakunin, Y.-C. Huang, E.D. Mishina, A.S. Sigov, *Laser Phys. Lett.* **10**, 055404 (2013).