DIFFUSION ENHANCEMENT IN SOLIDS BY EXTERNAL FIELDS

I. G. Marchenko[1,2], V. Yu. Aksenova [1,2], I. I. Marchenko[3], A.V. Zhiglo[1]

[1]NSC "Kharkov Institute of Physics and Technology"
1 Akademicheskaya Str., Kharkiv 61108, Ukraine
[2]Kharkov National University, 4 Svobody Sq., Kharkiv 61022, Ukraine
[3] NTU "Kharkov Polytechnic Institute", 2 Kirpicheva Str., Kharkiv 61002, Ukraine

Diffusion plays a key role in numerous processes in physics, chemistry and biology. Variation in diffusion mobility influences the material microstructure formation. This structure defines the material properties such as hardness, fracture strength, electrical conductivity, corrosion resistance, magnetic characteristics, etc. Thus controlling the diffusion processes is an important tool in manipulating the physical properties of the materials. The main parameter governing the diffusion in industrial applications is the temperature. Normally the diffusion is enhanced as the temperature grows. Other thermal processes are concurrently enhanced by the temperature increase. For technological applications it is desirable to be able to selectively control the diffusion of certain defects, impurity atoms, etc. without changing the temperature.

In the current talk we show possible ways to control the properties of crystalline solids by affecting the diffusion mobility of point, linear or planar defects at constant temperature.

Based on works [1–7] we investigate the enhancement of diffusion of Brownian particles by applied constant or periodic in time external fields, in part of electromagnetic or acoustic nature. We show that the diffusivity can be increased by orders of magnitude by the external fields with the amplitudes close to special values. Under certain conditions the diffusivity in solids can exceed that in liquid at the same temperature. The described enhancement of diffusion significantly depends on the dissipation properties of the system as we will discuss in the talk. Finally, we will present conditions under which TAD ("temperature-anomalous diffusivity" [7]) is realized, i.e. the growth of diffusivity with temperature decrease.

[1] I. G. Marchenko, I. I. Marchenko, Europhys. Let. 100, 50005 (2012).
[2] I. G. Marchenko, I. I. Marchenko, A. V. Zhiglo, Euro. Phys. Journ. B87, 10 (2014).
[3] I. G. Marchenko, I. I. Marchenko, JETP Lett. 95, 137 (2012).
[4] I. G. Marchenko, I. I. Marchenko, Journ. of Phys. Conf. Ser. 514, 012045 (2014).
[5] I. G. Marchenko, I. I. Marchenko, V.I. Tkachenko, JETP Lett. 106, 242 (2017).
[6] I. G. Marchenko, I. I. Marchenko, A.V. Zhiglo, Phys. Rev. E97, 012121 (2018).
[7] I. G. Marchenko, I. I. Marchenko, V.I. Tkachenko, JETP Lett. 109**,** 671 (2019).