Elastic and Non-Elastic Properties of Auxetic Crystals

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Auxetic structures characterized by an abnormally negative value of the Poisson coefficient belong to materials with essentially nonlinear deformation properties and make it possible to vary and improve considerably the properties of the existing structural materials. The first reports on the existence of auxetic structures capable of expanding in the direction normal to their tension appeared long ago [1]. However, the problem of experimental, as well as theoretical study of their properties is still far from being solved. This applies especially to partially auxetic crystalline materials whose properties change considerably as a function of the direction in crystal and of the state and dynamic properties of their defective subsystems.

Beryllium belongs to partially auxetic hexagonal crystals and has negative values of tensor components of the Poisson coefficients ν_{ij} only in certain crystallographic directions [2]. Moreover, both positive and negative values of ν_{ij}, due to specific elastic properties of this structural material, lie in the range from 0.02 to 0.05, which has essential impact on the behaviour of its defective subsystems, specifically the “dislocation-impurity” one.

In this paper, we have studied the elastic (effective shear modulus G_{ef}) and non-elastic (low-frequency internal friction Q^{-1}) properties of beryllium of various purity level: from 98% to 99.95 % Be on the as-prepared samples, as well as after natural aging. Characteristics in question were studied with a change in temperature in the range from -50 to 450 °C, amplitude of torsional strain in the range from 1 to $70\cdot10^{-6}$ and time with different temporal aging bases. It is shown that the anomalies of G_{ef} and Q^{-1} in Be in the investigated temperature range “correlate” with the appearance of auxetic properties.

[1] D.A.Koniok, K.V.Woiciechovski, Yu.M.Pleskachevsky, and S.V.Shilko, Mechanics of Compositional Materials and Structures, 1(35) (2004).
[2] R.V. Goldstein, V.A. Gorodtsov, and D.S. Lisovenko, Letters on Materials, 3 (7), (2013).