

Influence of the Loading Regime of Indentation on the Hardness of Phosphate Glass

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Phosphate glasses are largely investigated in the last decades for their optical, maneto-optical and biological properties. Glasses based on phosphate oxide with different dopants are successfully applied as fast ion conductors, waveguides, optical switches, fibers, as well as the main component in active bioglass for bone and teeth curing. Chemical stability and mechanical strength, very important for above mentioned applications, can be achieved by changing the composition and preparation conditions of the glass. In this study a new composition of phosphate glass ($56,66\text{LiPO}_3-28,33\text{Al}(\text{PO}_3)_3-10\text{Ba}(\text{PO}_3)_2-2\text{La}_2\text{O}_3-3\text{RE}_2\text{O}_3$ (RE = Dy, Tb)) obtained by sol-gel method is investigated from the point of view of mechanical behavior. For this purpose a multifunctional and universal technique of nanoindentation have been used. Different deformation regimes, beside the standard one, like cyclic loading, prolonged holding under the maximum load, low and high loading rates and their combination, which modeled the real conditions of wear and fatigue, were applied to study the mechanical behavior of material.

The influence of: (i) loading rate - 2 and 20mN/s; (ii) holding time under the maximum load - 5, 100 and 300s; (iii) number of indentation cycles (1 and 3) and their combination, on the hardness (H) of glass were investigated. It was shown that higher loading rate increases the values of hardness for all used regimes/conditions of loading, while cyclic indentation (3 cycles), prolonged holding time under the maximum load (100 or 300s) and their combination decreases the hardness (Fig. 1). These results suggest about the dependence of the deformation processes in phosphate glass on the time-loading conditions resulting in the loss of material strength when longer time of loading is applied.

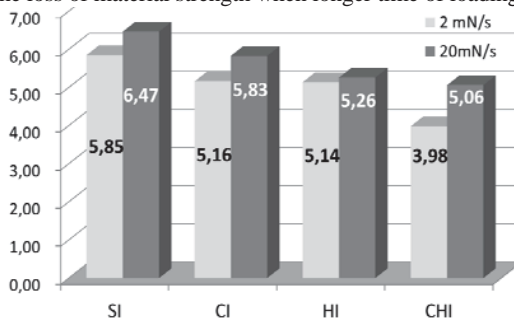


Fig. 1. The values of hardness for phosphate glass doped with Dy for different loading conditions: loading rate (shown in legend), SI - standard indentation with 5 s holding under the peak load, CI - cyclic indentation with 5 s holding, HI - indentation with prolonged holding of 300s, CHI - cyclic indentation with prolonged holding. The applied load in all used regimes was 100mN.