Conclusion

The cyclic rotary actuator was designed and made. The control algorithm of the cyclic actuator was considered. We provided experimental results on the control algorithm and the actuator. The diagrams of the cyclic mode without a load show dependents of the actuator parameters and the hysteresis loop bound conditions. We can realize the desired actuator mode by changing of this bound conditions and the cooling speed. If the conditions are the same, the each cycle of the actuator is the same and does not change by time. The next steps are investigation of the cyclic mode by load and a positioning of the shaft rotary angle. The results of this work have been applied in bionic prosthesis design in project by SPbPU.

Acknowledgements. *This work was supported by the Russian Science Foundation under Project 16–19– 00129.*

References

[1] Horikawa H, Ichinose S, Moorii K, Miyazaki S, Otsuka K. Orientation dependence of β→β` stress-induced martensitic transformation in a Cu-Al-Ni alloy. *Metallurgical Transactions A.* 1988;19(4): 915-923.

[2] Jani JM, Leary M, Subic A, Gibsone MA. A review of shape memory alloy research, applications and opportunities. *Materials and Design.* 2014;56: 1078-1113.

[3] Pulnev SA, Nikolaev VI, Malygin GA, Kuzmin SL, Shpeizman VV, Nikanorov SP. Generation and relaxation of reactive stresses in Cu-Al-Ni shape-memory alloy. *Technical Physics.* 2006;51(8): 1004-1007.

[4] Nikolaev VI, Pulnev SA, Malygin GA, Shpeizman VV, Nikanorov SP. Generation and relaxation of reactive stresses in a Cu-Al-Ni shape memory alloy upon cyclic temperature variation in the range 293-800 K. *Physics of the Solid State.* 2008;50(11): 2170-2174.

[5] Nikolaev VI, Averkin AI, Egorov VM, Malygin GA, Pulnev SA. Influence of incomplete shape memory deformation on the generation of reactive stresses in single crystals of the Cu-Al-Ni alloy. *Physics of the Solid State.* 2014;56(3): 522-526.

[6] Pulnev S, Nikolaev V, Priadko A, Rogov A, Viahhi I. Actuators and Drivers Based on CuAlNi Shape Memory Single Crystals. *Journal of Materials Engineering and Performance*. 2010;20(4-5): 497-499.

[7] Priadko AI, Pulnev SA, Nikolaev VI, Rogov AV, Shmakov OA, Golyandin SN, Chikiryaka AV. Investigation of single crystal Cu-Al-Ni alloy bending force elements for linear motors. *Materials Physics and Mechanics.* 2016;29(2): 158-165.

[8] Priadko AI, Nikolaev VI, Pulnev SA, Stepanov SI, Rogov AV, Chikiryaka AV, Shmakov OA. Shape memory Cu-Al-Ni single crystals for application in rotary actuators. *Materials Physics and Mechanics.* 2017;32(1): 83-87.

[9] Belyaev SP, Voitenko YV Kuzmin SL, Likhachev VA, Kovalev VM. Cyclic shape memory and the operating capacity of titanium nickelide. *Strength of Materials.* 1989;21(6): 748-752.

[10] Belousov VL, Dukin AD, Favstov YK. Executive mechanism of multiple action with reciprocating motion. In: *Materials with the effect of shape memory and their application.* Novgorod: 1989. p.191-192.

[11] Ostapenko AV. Efficiency of martensitic engines and methods for increasing it. In: *Materials with the shape memory effect and their application.* Novgorod: 1979. p.125-129.