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EXPERIMENTAL RESEARCH ON TECHNOLOGY OF MANUFACTURING AND BURNING OF AIRCRAFT STRUCTURES MADE OF MULTICOMPONENT MATERIALS

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The analysis of the state of modern technologies for utilization of reinforced polymers is carried out. The task of the study was formulated. Based on thermodynamic analysis and consideration of various combinations of compositions for conducting experiments, six types of test multicomponent samples were selected for conducting experimental studies on their combustion. To determine the maximum combustion temperature, the ignition temperature of the samples, and the mass of combustion residues. The analysis of the results obtained was carried out, and the compositions of the components for further research were identified.

Keywords: combustion, plastics, energy materials, separated parts of aircraft and spacecraft.

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References

1. Kirillov V. N., Efimov V. A., Shvedkova A. K., Nikolayev E. V. Issledovaniye vliyaniya klimaticheskikh faktorov i mekhanicheskogo nagruzheniya na strukturu i mekhanicheskiye svoystva PKM [Testing of climatic factors and the mechanical loading effect upon the polymer composite structure and properties] // Aviatsionnyye materialy i tekhnologii. *Aviation Materials and Technologies*. 2011. No. 4 (21). P. 41–45. (In Russ.).

2. Kablov E. N., Startsev O. V., Krotov A. S., Kirillov V. N. Klimaticheskoye stareniye kompozitsionnykh materialov aviatsionnogo naznacheniya. I. Mekhanizmy stareniya [Climate ageing of composite materials for aircraft purpose. I. Mechanisms of ageing] // Deformatsiya i razrusheniye materialov. *Deformation and Fracture of Materials*. 2010. No. 11. P. 19–27. (In Russ.).

3. Trushlyakov V., Panichkin A., Lempert D., Davydovich D. [et al.]. Method of heating of the separated parts of launch vehicle during the atmospheric phase of the descent trajectory // Acta Astronautica. 2019. Vol. 157. P. 1–8. DOI: 10.1016/j.actaastro.2018.12.015. (In Engl.).

4. Trushlyakov V., Davydovich D. The Use of Pyrotechnic Composition for Dispersing Fairings During Atmospheric Re-entry // Procedia Engineering. 2017. Vol. 174. P. 4–10. DOI: 10.1016/j.proeng.2017.01.130. (In Engl.).

5. Patent 2672683 Russian Federation, IPC F 42 B 15/36, B 64 G 1/64. Sposob minimizatsii zon otchuzhdeniya otdelyayemykh chastey rakety-nositelya [Method for minimizing the exclusion zones of separable parts of the launch vehicle] / Trushlyakov V. I., Davydovich D. Yu., Lempert D. B., Shatrov Ya. T., Monogarov K. A., Murav'yev N. V. No. 2017141320. (In Russ.).

6. Petrov A. V., Doriomedov M. S., Skripachev S. Yu. Tekhnologii utilizatsii polimernykh kompozitsionnykh materialov (obzor) [Recycling technologies of polymer composite materials (Review)] // Trudy VIAM. *Proceedings of VIAM*. 2015. No. 8. P. 1–7. DOI: 10.18577/2307-6046-2015-0-8-9-9. (In Russ.).

7. Palmer J., Ghita O. R., Savage L., Evans K. E. Successful closed-loop recycling of thermoset composites // Composites Part A: Applied Science and Manufacturing. 2009. Vol. 40 (4). P. 490–498. DOI: 10.1016/j.compositesa.2009.02.002. (In Engl.).

8. Sabadakha E. N., Prokopchuk N. R., Shutova A. L., Globa A. I. Termostabil'nyye kompozitsionnyye materialy [Thermostable composite materials] // Trudy BGTU. Seriya 2: Khimicheskiye tekhnologii, biotekhnologiya, geoekologiya. *Proceedings of BSTU. Issues Chemistry, Organic Substances Technology and Biotechnology*. 2017. No. 2 (199). URL: https://cyberleninka.ru/article/n/termostabilnye-kompozitsionnye-materialy (accessed: 09.01.2020). (In Russ.).

9. Nistratov A. V., Vu Kim Long, Klushin V. N., Mishkin S. I. [et al.]. Termograficheskoye issledovaniye otkhodov ugle- i organoplastikov kak sredstvo otsenki ratsional'nykh usloviy ikh destruktsii [Thermographic analysis of waste carbonand organic plastics as way of evaluation of rational conditions of their destruction] // Trudy VIAM. *Proceedings of VIAM*. 2017. No. 11 (59). P. 98–106. DOI: 10.18577/2307-6046-2017-0-11-10-10. (In Russ.).

10. Burdyugov S. I., Batrakova G. M., Vaysman Ya. I., Karmanov V. V. Issledovaniye effektov termicheskogo razlozheniya kompozitsionnykh materialov konstruktsionnogo naznacheniya [Analysis of thermal decomposition effects in structural composites] // Khimicheskaya fizika i mezoskopiya. *Chemical Physics and Mesoscopy*. 2011. Vol. 13 (3). P. 319–325. (In Russ.).

11. GOST 25.601-80. Raschety i ispytaniya na prochnost'. Metody mekhanicheskikh ispytaniy kompozitsionnykh materialov s polimernoy matritsey (kompozitov). Metod ispytaniya ploskikh obraztsov na rastyazheniye pri normal'noy, povyshennoy i ponizhennoy temperaturakh [Design calculation and strength testings. Methods of Mechanical testing of Polymeric Composite Materials Test for Tensile Properties on Plane Specimens at Normal, Elevated and Low Temperatures]. Moscow, 2005. 12 p. (In Russ.).

12. Trusov B. G. Modelirovaniye khimicheskikh i fazovykh ravnovesiy pri vysokikh temperaturakh [Modeling of chemical and phase equilibria at high temperatures]. Moscow, 1995. 96 p. (In Russ.).

13. Lysych M. N., Shabanov M. L., Kachurin A. A. Obzor sovremennykh tekhnologiy 3d pechati [Review modern technologies 3d printing] // Sovremennyye naukoyemkiye tekhnologii. *Modern High Technologies*. 2015. No. 6. P. 26–30. (In Russ.).

14. Lebedev S. M., Gefle O. S., Amitov E. T., Zhuravlev D. V. [et al.]. Mechanical properties of PLA-based composites for fused deposition modeling technology // The International Journal of Advanced Manufacturing Technology. 2018. Vol. 97, Issue 1–4. P. 511–518. DOI: 10.1007/s00170-018-1953-6. (In Engl.).

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