Proceedings of the 7th International Conference on Mechanics and Materials in Design,
Albufeira/Portugal 11-15 June 2017. Editors J.F. Silva Gomes and S.A. Meguid.
Publ. INEGI/FEUP (2017)

PAPER REF: 6524

THE INFLUENCE OF THE ADDITION OF NANOTUBES ON THERMO-PROTECTIVE ABLATIVE PROPERTIES OF EPOXY RESIN IN AVIATION APPLICATIONS

Paweł Przybyłek[1(*)], Robert Szczepaniak[1], Andrzej Komorek[1], Wojciech Kucharczyk[2]
[1]Facultyof Airframe and Engine, The Polish Air Force Academy, Poland
[2]Faculty of Mechanical Engineering, University of Technology and Humanities in Radom, Poland
[(*)]*Email:* p.przybylek@wsosp.pl

ABSTRACT

The study presents research which attempts to determine the possibilities of modifying thermo-protective ablative properties of resin used in aviation applications. In order to modify the properties, we used the addition of nanotubes in the proportions of 1%, 2%, 3%, 5% (volume shares). We used the following parameters to assess the thermal protection: the ablation mass waste, average linear rate of ablation (!) and the back side temperature of the specimens) The performed tests as well as the obtained findings allowed formulating a number of conclusions which are useful in creating future composites.

Keywords: ablative, passive fire-proof protections, epoxy composites.

INTRODUCTION

The use of modified plastics as ablative materials protecting against an excessive temperature increase was connected with the middle of 20th century, directly with arms industry as well as aeronautical, rocket and space technologies. These materials can also be used in the design of passive fire-proof protections for large cubature supporting elements in building structures, communication tunnels and for the protection of data stored in electronic, optical and magnetic carriers, the thermal protection system of rocket nozzles, space vehicles and rocket combustion chambers. The authors analysed an impact of the addition of carbon nanotubes upon the selected ablation properties. The aim of this article is to answer the question of the influence of the quantitative and qualitative phase composition of epoxide resin with selected nanotubes upon ablative thermo-protective properties of these composites, especially on the back side temperature of specimen t_s and the mass waste U_a. In order to carry out the investigation, we prepared 10 samples with a diameter of 40 mm and two kinds of thickness, 6 mm and 12 mm. The matrix of the composite was prepared by LH145 epoxide resin matrix base cured with H147 agent. The properties of the composite were modified by changing the volume share in the matrix of carbon nanotubes (IGCWNTs), which were as follows: 1%, 2%, 3%, 5% (volume shares). The samples were subjected to ablation testing by exposing to a high temperature heat flux for a period of τ = 90 seconds and the flame temperature of 800 °C

RESULTS AND CONCLUSIONS

Figure 1 shows the final temperature of the rear surface of the wall of the isolating sample. The temperature of the rear surface of the wall in the 6 mm sample, grow from 80 °C, in the initial phase of burning, rapidly (until complete damage), even reaching the values of

approximately 300 °C. In the case of 12 mm thick samples, the temperature of the rear surface of the wall of the sample grows slightly in the course of the investigation, finally reaching the temperature of about 50 °C.

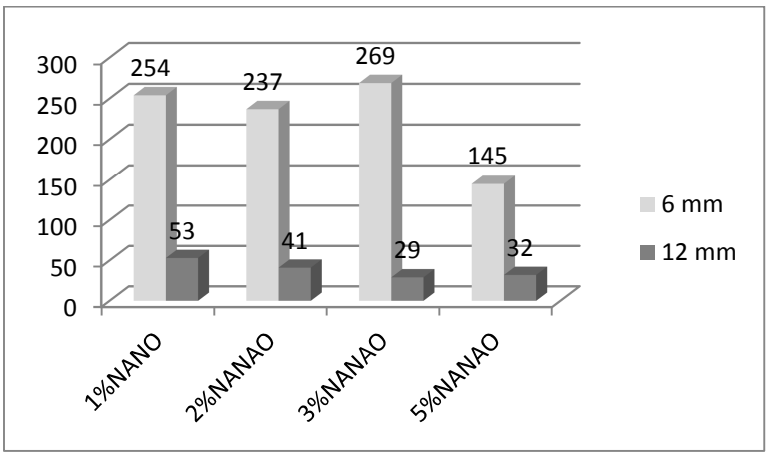

Fig. 1 - Final temperature of the rear surface of the wall of the isolating sample

On the basis of the conducted experimental investigation, we formulated the following conclusions:

While comparing the composite sample in terms of thickness, it appears that 12 mm samples are more resistant to the heat flux rather than those which are 6 mm thick.

The addition of nanotubes to 3% does not seem to affect the temperature of the back surface of the wall of the isolating sample. Only a 5% addition led to the reduction of the temperature of the rear wall of the isolating sample almost by 100 °C (i.e. approximately 40%).

In the case of the nanotubes whose amount exceeds 3%, increasing the volume share of the nanofiller causes a relative ablative mass loss by approximately 5%.

REFERENCES

[1]-Bian, L.P.; Xiao, J.Y.; Zeng, J.C.; Xing, S.L.; Yin, C.P. Microstructural interpretation of the ablative properties of phenolic-quartz hybrid fabric reinforced phenolic resin composites. Mater. Des. 2014, 62, 424-429.

[2]-P.Sanoj and Balasubramanian Kandasubramanian Hybrid Carbon-Carbon Ablative Composites for Thermal Protection in Aerospace**,** Journal of Composites Volume 2014 (2014),doi 10.1155/2014/825607.

[3]-Badhe, Y.; Balasubramanian, K. Novel hybrid ablative composites of resorcinol formaldehyde as thermal protection systems for re-entry vehicles. RSC Adv. 2014, 4, 28956-28963.

[4]-Przybyłek P., Kucharczyk W.: Możliwości zwiększenia odporności cieplnej rejestratorów lotniczych poprzez zastosowanie osłon z polimerowych kompozytów ablacyjnych, Journal of Aeronautica Integra, 2/2011 (9), pp 50-56.

[5]-Feng-Er, Y. (2004). Study on the ablation materials of modified polyurethane/polysiloxane. Unpublished doctoral dissertation, National Sun Yat-sen University, Guangzhou, People Republic of China.