DEGRADATION OF MECHANICAL PROPERTIES OF LAYERED POLYMER COMPOSITES "(PEEK/PEI) - CF FABRIC-BASED PREPREG" UNDER FATIGUE*

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Cyclic mechanical loading of machine parts and structural elements is one of the main reasons for their failure. Therefore, the analysis of deformation behavior during cyclic loading of structural materials, including polymer composites and their permanent joints, is an urgent problem [1,2]. An effective approach to studying fatigue processes is the analysis of mechanical hysteresis loops linking the reaction of the loaded material in the form of strain versus the applied load [3]. The integrated data from the force gauge of the testing machine is sufficient to assess the load /stresses; however, the assessment of (local) strain using a contact opening sensor is not always possible. Moreover, in the case when the polymer composite or its permanent joint does not have a completely homogeneous structure, the use of an opening sensor is not entirely rational. Thus, for the quantitative assessment of fatigue deformation of polymer composites and their permanent joints, the use of non-contact methods is required, which, among other things, provide the possibility of obtaining data on its distribution over the entire analyzed area.

Ultrasonic welding (USW) is an effective method of joining parts made of thermoplastic materials and their composites [4]. Recently, research has been actively conducted on the use of ultrasound for bonding layered composites (laminates) based on thermoplastic matrices. When varying the material of the thermoplastic binder and the carbon fibers mainly used in them as a reinforcing component, the following tasks are solved: i) search for the optimal combination of technological parameters of the ultrasonic welding; ii) choice of material and configuration of the energy director; iii) ensuring maximum uniformity of the structure of the fusion zone, etc.

The aim of the study was to establish the relationship between the structure and resistance to cyclic loading of layered composites "PEI (PEEK) plate / PEI (PEEK) film /Prepreg made of PEI-impregnated CF fabric / PEI (PEEK) film / PEI (PEK) plate " based on the analysis of time variation in the parameters of mechanical hysteresis loops calculated with the use of the Digital Image Correlation (DIC) method. To achieve this goal, the following tasks were solved. To fabricate samples of permanents joints. To investigate the patterns of fatigue failure development under of low and conditional high cycle fatigue of the studied composites. To analyze the data obtained, including the results of numerical experiments on the loading of lap joints with varying levels of interlayer adhesion.

It is shown that in a layered composite based on polyethyrimide (PEI) under realized fatigue loading conditions (0.8 of the yield point), the incompatibility of deformation of PEI plates and prepreg associated with the formation of an interlayer interface from a low-melting TecaPEI film caused low fatigue life. In the PEEK-layered composite, the interlayer interface was formed from an energy director made of neat PEEK, which made it possible to form a low-defect interface that ensures reliable load transfer from the PEEK plates to the central reinforcing layer (prepreg). As a result, fatigue life at a load level of 0.8 of the yield point corresponded to multi-cycle fatigue (more than 86 thousand cycles).

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