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ROZPRAWA DOKTORSKA

Termograficzna metoda oceny rozkładu udziału włókien w kompozytach epoksydowo–węglowych

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ABSTRACT

In this dissertation, a possibility of application of the active thermography for the quantitative analysis of fiber content distribution in carbon–epoxy composite materials was presented. The primary purpose of the experimental investigations was to obtain the data needed to form the diagnostic models which relate a chosen parameter of non-steady state heat flow with fiber content in the investigated composite. The measurements has been performed using a special testing station which was designed and build to realize the purpose of the investigation. Square shaped specimens with different thickness and different fiber content were prepared by conventional hand lay-up. All specimens were painted with a thin layer of matt black coating to ensure consistency in surface emissivity and to eliminate spurious reflections from e.g. overhead lights or humans. To carry out the thermographic investigations, it was necessary to determine the optimum heating conditions for the measurements, which ensure established temperature increase on the rear surface of the specimen without exceeding the maximal permissible temperature i.e. degradation temperature of the material. This experiment was treated as preliminary research of this dissertation. The results of preliminary research gave a possibility to create the plan of fundamental thermographic investigations. The primary purpose of the fundamental research was to obtain the time–temperature characteristics for all investigated specimens. The time–temperature characteristics were used to determine the thermal diffusivity values of the composites and neat resin specimens using flash diffusivity method. Neat resin specimens were applied to investigate the effect of specimen thickness on the measured value of thermal diffusivity. It was found from this investigation that the thermal diffusivity measurement was affected by specimen thickness, so the real quantity which was determined during thermographic experiment was so-called “apparent thermal diffusivity”. However, due to the purpose of the present dissertation, the knowledge of exact absolute values of the thermal diffusivity was of less importance. More important and sufficient was to determine the relative values which were possible to obtain during experiment, which provided the data needed for creation the dependences that relate the thermal diffusivity with fiber content. On the basis of created dependences, the diagnostic models was formed. This models can be used for quantitative assessment of the fiber content distribution in carbon–epoxy composite materials with the thickness range from 3 to 8 millimeters. The models, for all series of specimens, are in the form of linear equations with different parameters for different thickness of specimen. The analysis of the thermal images obtained during thermographic investigations, indicates that it is possible to localize the area of the composite which includes the non-uniform distribution of fiber content.