Analysis of damage in a composite by X-ray tomography using the structure tensor

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The aim of the work is to obtain damage characteristics of the structure of a loaded carbon fiber-based composite material based on the data of micro-CT research by the example of identification of macroscale defects using image analysis methods. To determine the processes of damage accumulation near stress concentrators during deformation of polymeric composite sample, quasistatic deformation was carried out. The flat strip composite specimens were made of CW200-TW2/2 twill woven carbon fabric with epoxy matrix, with an even number of pairs of layers with different orientation of the warp to the loading axis. X-ray microtomography using synchrotron-radiation source was performed on the equipment of the INP SB RAS. We investigate damage analysis based on the field determination of the structure tensor of a representative volume of the composite, which makes it possible to determine both technological defects and accumulated damage during the deformation process. Based on the results of the probability density functions (PDF) analysis, it was found that the anisotropy factor as well as the sum of the squares of the intensity distribution field derivatives (structure tensor invariant) are sensitive parameters for damage detection. In addition, it was found that the PDF become non-monotonic in the case of detection of technological defects, which can also be reflected in the occurrence of deformation damage.
The work was supported by RSF project No. 21-79-30041.