ICCES, 2023, vol.25, no.3
DOI: 10.32604/icces.2023.010047

PROCEEDINGS

Monte Carlo Simulation of Photon Transport in Composite Materials

Ping Yang[1] and Pengyang Zhao[1,*]

[1] Department of Engineering Mechanics, School of Naval Architecture, Ocean and Civil Engineering, Shanghai Jiao Tong University, Shanghai, 200240, China

[*]Corresponding Author: Pengyang Zhao. Email: zhao.py@sjtu.edu.cn

ABSTRACT

Composite materials may be subjected to an extreme condition where the surface is exposed to high-energy photon radiation (e.g., laser radiation), which can cause severe damage and destruction of the structure component. How the radiation energy is deposited in the composite material can greatly influence the subsequent damage process, which may include local heating, phase transformation, heat-induced shock waves, plasticity, etc. While the interaction of high-energy photons with homogeneous materials have been well studied, it is still a challenge to model the photon transport in composite materials, which have been increasingly used in more and more structural components. In this study, we propose a Monte Carlo model to simulate the photons transport in structurally and chemically heterogeneous materials. The model is first verified and validated by comparison with the existing open-source software Geent4 for a case study of photon deposition curve in a single layer aluminum. The model is then applied to studying the photon energy deposition in carbon fiber and epoxy resin. The simulation results show that while it is the epoxy resin that is mainly exposed as the surface of the structure, the radiation energy is actually deposited more in the carbon fibers than in the former. Detailed analysis shows that it is mainly due to the fact that the photon absorption capacity of the carbon fiber is higher than that of the epoxy resin. We believe that this model has the potential to be further applied to more complicated cases where the structural and material heterogeneity may play a significant role in photon energy deposition.

KEYWORDS

Photon transport; composite material; Monte Carlo model; energy deposition

Funding Statement: The authors received no specific funding for this study.

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.