【Grant-in-Aid for Scientific Research(S)】
Science and Engineering (Engineering Ⅱ)

Title of Project : Process Clarification and Practical Realization of Direct In-situ Processing Method of Carbon Fiber Reinforced Thermoplastics

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Research Area : Integrated engineering, Aerospace engineering
Keyword : Structure/Material, Composites

【Purpose and Background of the Research】

Carbon fiber reinforced plastics (CFRP) play an irreplaceable role to realize sustainable society. However they are costly due to expensive prepregs*, and autoclaves, and long processing time. Moreover, high-strength CFRP are difficult to be recycled, and their possible size is restricted to the scale of the autoclave practically available. To overcome these issues, a new molding method for carbon fiber reinforced thermoplastics (CFRTP) is developed in the present study. In the method as schematically shown in Fig. 1, an in-situ molding technique without prepregs and autoclaves is explored: a thermoplastic tape and carbon fiber tow are directly heat-pressed, cured and is laminated in a specific direction on a mold. Efforts will be made to understand the physical processes such as thermal conduction in materials, bonding, and impregnation of resin into fibers, and the molding processes of CFRTP are examined. In addition, the deformation and fracture processes during high speed impact loading are examined for realistic and broader range of applications.

*Intermediate products composed of reinforcement fibers or cloths pre-impregnated with a resin

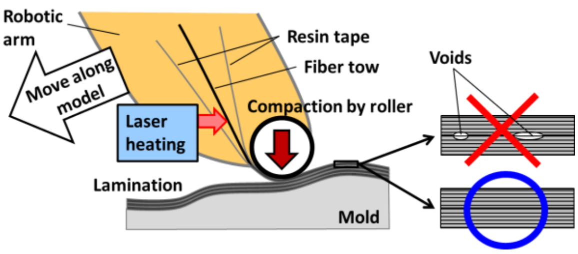

Figure 1 In-situ CFRTP molding system

【Research Methods】

The physical, molding, and deformation and fracture processes in the proposed in-situ molding system are concurrently investigated. The findings are eventually integrated to reach a feasible solution for the system. For this purpose, several prototypes are designed and tested. How controlling parameters such as laser power, compaction loading, feeding rate, thermophysical properties and specifications of materials affect the microscopic and macroscopic characteristics of the CFRTP such as mechanical properties and void distribution is evaluated. To analyze the deformation and fracture processes in a time-resolved manner, high-speed visualization and velocity interferometry methods are applied. The overall understanding lead us an optimal molding condition in the integrated system.

【Expected Research Achievements and Scientific Significance】

An innovative laser-assisted in-situ CFRTP molding method to be established in the present study is different from existing tape placement methods in the sense that the proposed method does not use the prepregs, and that the optimal molding condition is based on the understanding of the overall processes to be elucidated in the present study. The method enables us a new value for CFRTP: both low cost and high quality conditions, which have been inconsistent so far, are satisfied. This new value contributes to realize a sustainable society in the future.

【Publications Relevant to the Project】

・T. Ishikawa, et al., "Some Experimental Findings in Compression-After-Impact Tests of CF/PEEK(APC-2) and Conventional CF/Epoxy Flat Plates," Composites Science and Technology, Vol. 55 No. 8, pp. 349-363, (1995).
・Y. Yamada, et al., "Three-dimensional Measurement of CFRP Deformation during High-speed Impact Loading," Nuclear Instruments and Methods in Physics Research A, Vol. 646, pp. 219-226, (2011).

【Term of Project】 FY2013-2018

【Budget Allocation】 174,740 Thousand Yen

【Homepage Address and Other Contact Information】

http://structure.nuae.nagoya-u.ac.jp/