

Comparative Study of FEM-based Structural Analysis and Laser Ultrasonic Testing Results on CFRP Combustion Chambers of Hybrid Rockets

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This study carries out a comparative analysis between the Finite Element Method (FEM)-based structural analysis results and Laser Ultrasonic Testing (LUT) results on Carbon Fiber Reinforced Plastic (CFRP) combustion chambers of hybrid rockets after conducting combustion tests. After defining the load and boundary conditions relevant to the combustion tests, the stress distribution and potential defect areas within the CFRP combustion chambers are analyzed using an FEM-based structural analysis model. The structural analysis results are compared with the non-destructive testing data obtained from LUT. This comparison process not only validates the accuracy and reliability of the analytical model but also identifies hidden defect areas in the CFRP combustion chambers that could not be detected by FEM alone. Through the comparison between FEM and LUT results, a deeper understanding of the mechanical characteristics and reliability of CFRP combustion chambers is achieved. Consequently, the analytical model of the CFRP combustion chambers, which are used in actual space launch vehicles, has been validated based on LUT data. The insights gained from this study significantly contribute to enhancing the safety and reliability of CFRP combustion chambers in hybrid rockets. Furthermore, the analytical model, verified through the combination of FEM and LUT methodologies, serves as an important reference for evaluating the lifespan and reusability of combustion chambers.