PROCESS INTEGRATED IN-SITU STRUCTURAL EVALUATION FOR SIGNIFICANT MATERIAL AND COST SAVING BY INDUSTRY 4.0

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Abstract

Contemporary composite part development and manufacturing, in particular of high performance light weight structures, is still challenging. Great efforts are needed in order to find optimal process parameters and to meet required qualities and tolerances. However, depending on the complexity of the part as well as on the selected process technology and material type the resulting products still contain different manufacturing deviations that effect the structural properties. As a consequence several conservatisms rule the development and manufacturing process of light weight structures. On the one hand this prevents the exploitation of structural reserves. On the other hand non-added value manufacturing and rework processes unnecessarily increase manufacturing costs, waste of material and energy consumption.

This paper describes an innovative composite manufacturing concept with an integrated in-situ structural evaluation process in order to enable an automated and individual assessment of structural properties and performance from a global perspective. This concept, which was developed within the European funded project ECOMISE, requires the following steps: Prior to manufacturing typical manufacturing features such as locally varying fibre architecture or temperature variations are studied based on experience from previous manufacturing as well as from probabilistic process simulation. Further, the effects of features on the structural properties are investigated for the expected parameter ranges. So-called surrogate models and databases are derived based on this knowledge enabling full probabilistic analysis and fast process optimization, while taking into account robustness requirements. During manufacturing the real detected features are provided by online monitoring systems. This information in turn serves for an in-situ structural evaluation of their effect on the overall structural performance directly during manufacturing. Moreover, an in-situ decision making and process adjustment are derived to reestablish the required part properties. For verification and validation of this integrated manufacturing concept tests are performed by manufacturing representative coupon structures as well as industrial demonstrators. Results are presented in detail. Thus, key technologies are provided for industry 4.0 in order to maximize process efficiency at reduced cost and time while maintaining structural requirements.

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