Prediction of the Quality of Thermally Sprayed Copper Coatings on Laser-Structured CFRP Surfaces Using Hyperspectral Imaging

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With the progressive replacement of metallic parts by high-performance fiber-reinforced plastic (FRP) components, typical properties of metals are required to be placed on the material's surface. A metallic coating applied to the FRP surface by thermal spraying, for instance, can fulfill these requirements, including electrical conductivity. In this work, laser pre-treatments are utilized for increasing the bond strength of metallic coatings. However, due to the high-precision material removal using pulsed laser radiation, the production-related heterogeneous fiber distribution in FRP leads to variations in the structuring result and consequently to different qualities of the subsequent coating. In this study, hyperspectral imaging (HSI) technologies in conjunction with deep learning were applied to carbon fiber-reinforced plastics (CFRP) structured by nanosecond pulsed laser. HSIbased prediction models could be developed, which allow for reliable prediction, with an accuracy of around 80%, of which laser-treated areas will successfully be coated and which will not. By using this objective and automatic evaluation, it is possible to avoid large amounts of rejects before further processing the parts and also to optimize the adhesion of coatings. Spatially resolved data enables local reworking during the laser process, making it feasible for the manufacturing process to achieve zero waste.