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Characterization of CFC/Cu joints by full-field measurements and finite elements

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In this communication focus is posed on a joint between a Carbon Fiber reinforced carbon-matrix Composite (CFC) and copper (Cu or its alloys), based on the modification of the CFC substrate and on a one-step brazing process with a non-active brazing alloy [1][2]. Such kinds of joints are realized for thermal management while ensuring structural functions, see e.g. [3].

Small CFC/Cu samples joined by the one step-brazing process mentioned above were subjected to several mechanical tests at room temperature such as torsion tests, single-lap and double-lap shear tests with and without offset, the standard test ASTM B898, see [4]. An unexpected scatter of data was found among these experiments, and further investigations by alternative approaches were therefore required.

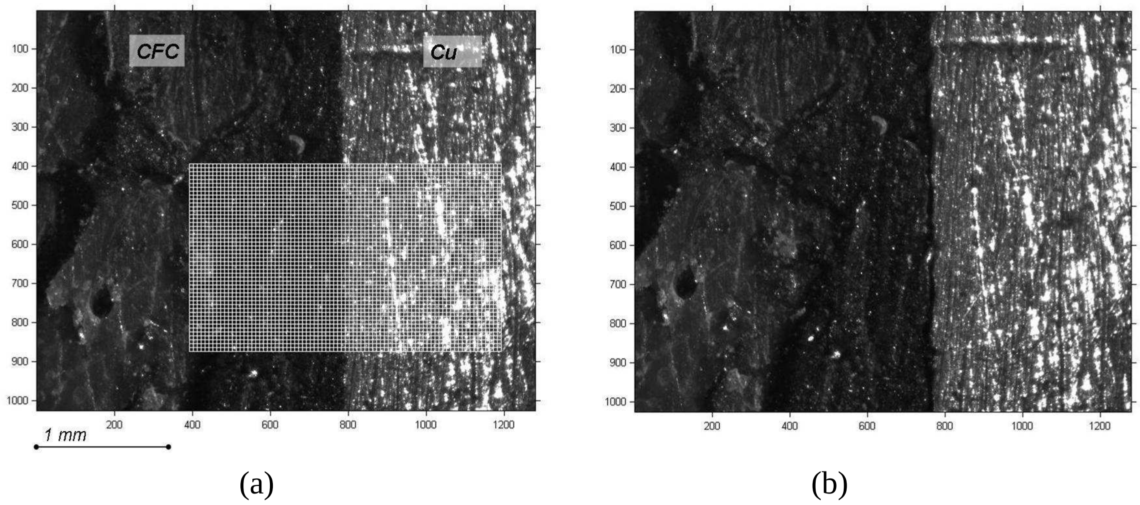

Figure 1: Monitored surface of the joined sample subjected to single-lap shear test in the reference, undeformed state, in (a), and at collapse with a complete joint failure, in (b). Superimposed to the sample natural texture in (a), the finite element discretization for DIC is shown (with 10 pixel side elements).

To investigate the mechanical response of the CFC/Cu joints subjected to single-lap shear tests [5], a numerical-experimental methodology is presented herein, which consists of two inverse problems in a sequence, coherently formulated and solved: (i) the “optical” inverse problem tackled by an improved 2D global Digital Image Correlation procedure, allowing one to reconstruct displacement fields from digital images (see e.g. [6]); (ii) the “mechanical” inverse problem, exploiting kinematic full-field measurements and a finite element model to estimate the governing parameters for the innovative joint [7]. In Figure 1 the monitored surface of the joined sample is shown, in the reference state, in (a), and at failure, in (b).

A perturbation study, based on σ-point strategy [8], allows one to assess with a low computational effort the stability of the overall procedure in the presence of uncertain adherent properties, assumed to be known a priori and playing the role of a diffuse “load cell”.

The proposed methodology can provide a useful feedback to improve the design process and the validation stage of innovative joining techniques.

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