C. Merino[1], J.A. Artero-Guerrero[3], T. Blanco[2], A. Butragueño[2], R. del Cuvillo[3], J. Pernas-Sánchez[3], D. Varas[3], S. Blanco[1], P. Merino[1], A. Reguero[4], E. Cholbi[4], B. Romero[4], J. López-Puente[3]

[1] Grupo Antolin Ingeniería SA. Ctra. Madrid – Irún, km.244.8, E09007 Burgos, Spain
[2] AIRBUS, Paseo John Lennon s/n, E28906 Getafe, Spain
[3] University Carlos III Madrid, Avda. de la Universidad 30, E28911 Leganés, Madrid, Spain,
[4] AERNNOVA, Calle Río Zánzara s/n, E45007 Toledo, Spain

cesar.merino@grupoantolin.com

Graphene Related Materials enhancing polymer composites: An application to aerospace structures

Nowadays carbon fibre reinforced epoxy laminates represent the standard material in the designing and manufacturing of aeronautical composite structures. However, advantages related to metals manufacturing could represent an important menace for the role of composite materials in this industry. Therefore, new improvements in composite structures have to be seek in order to improve their competitiveness.

Despite of the high stiffness and strength-to-weight ratio of carbon fibre reinforced epoxy laminates, they are quite vulnerable to impact loading. Hail impacts, bird strike or even tool drops could produce important damages that reduce residual strength of the material. On the other hand, an important disadvantage of this kind of composites is the high cost of manufacturing, related to fiber preimpregnation and autoclave curing. Alternative manufacturing technologies such as Resin Transfer Molding (RTM) could represent a significant advantage due to their lower cost, although some properties of the laminates produced are lower than those of composites obtained by autoclave manufacturing.

Graphene is a nanomaterial that possess the higher stiffness and strength ever measured [1]. Therefore, the use of Graphene Related Material (GRM) for enhancing composite laminate materials could represent an important advance in order to reduce their impact vulnerability and to improve the performance of RTM composites.

In this work epoxy resin doped with GRM were used to manufacture carbon fiber aeronautical composites by RTM. A wide experimental characterization campaign was performed in order to ascertain the impact properties improvement of the laminates produced. Coupons manufactured without carbon fibre reinforcement were tested by quasistatic and high strain rate (Split Hopkinson Pressure Bar) experimental methodologies to evaluate the GRM performance. Concerning laminates, Double Cantilever Beam (DCB), low velocity impacts and Compression After Impact (CAI) tests were performed. Regarding experimental methodology, ASTM and AITM standard were followed, also new measuring techniques were used as 3D High Speed Digital Image Correlations. All tests were performed on GRM enhanced material and reference material to compare their results. One of the most promising results obtained is showed in Figure 1, where it can be seen that GRM enhanced material is able to increase CAI strength in 12%. This challenge entails the possibility to improve current aerostructure performances without significant changes either in their design or manufacturing process.

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References

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Figures

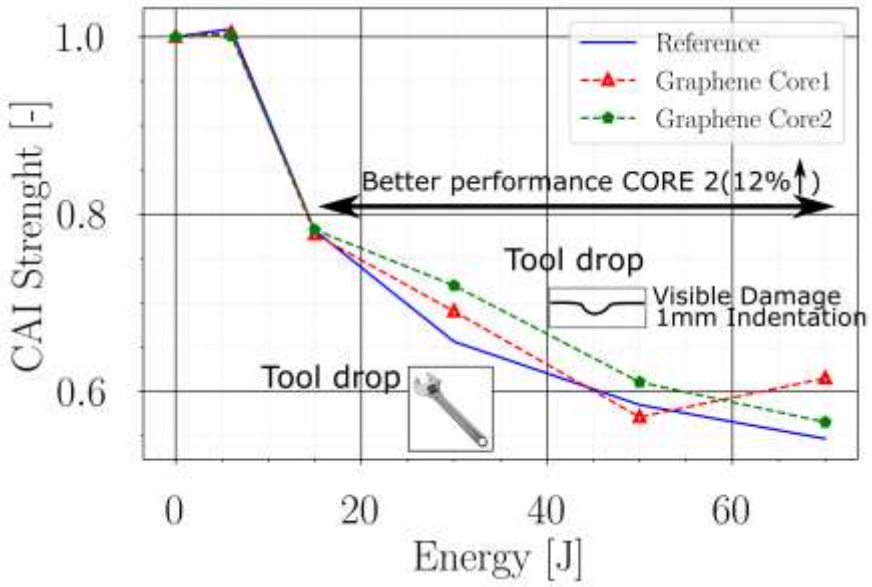

Figure 1: CAI strength of aerostructural composite RTM laminates: GRM-reinforced and reference composite.