Self-extinguishing epoxy nanocomposites containing industrial biowastes as flame retardant additives

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Book of Abstracts

analysis and multi-objective approaches to take into account all the aspects of interest at the same time.

Role of carbides in grain growth mitigation in additive manufacturing of Inconel 718

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Abstract: The integration of additive manufacturing (AM) for the production of aeronautical components often presents a trade-off between porosity in the as-built state and microstructural characteristics. The use of hot isostatic pressing (HIP) is a standard procedure for improving the part density. However, HIP erases the as-built microstructure and results in grain growth. Current research indicates that the incorporation of carbides can mitigate grain coarsening during powder bed fusion laser beam melting (PBF-LB/M) of Inconel 718, but at the expense of ductility. The objective of this study is to develop a method for controlling the grain size of Inconel 718 after PBF-LB/M processing and subsequent thermal treatments, including HIP, without compromising ductility and also achieving excellent fatigue properties. This was achieved by introducing micron-scale powder modifiers (NbC, TiC, and B4C) at minimal weight fractions. The research shows the effect of these modifiers on Inconel 718 powder properties, PBF-LB/M processability, microstructure and mechanical properties. The technological aspects of powder preparation and post-processing that affect the final properties of carbide-modified Inconel 718 are also examined. The results show that careful processing can control homogenization during HIP and result in higher tensile strength while maintaining the ductility of non-carbide-modified alloys.

Self-extinguishing epoxy nanocomposites containing industrial biowastes as flame retardant additives

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Abstract: Polymeric wastes can be found everywhere around the world. The improper treatment and recycling of such materials is causing irreversible damage to both human health and the environment. Therefore, it is getting urgent the development of more waste-to-wealth routes, enabling the preparation of polymer-based products containing small amounts of synthetic and toxic components (e.g., flame retardants (FRs)). Owing to their excellent physico chemical properties, flame retarded aliphatic epoxy resins are widely employed in the aerospace industry.

However, these resins usually contain halogen-based compounds or high concentrations of phosphorus (P) in the epoxy matrix, which makes the recycling of final products even more complicated and fosters the depletion of natural resources. To overcome these drawbacks, the scientific community is proposing the exploitation of industrial biowastes as sustainable FRs in epoxy-based composites, allowing for the use of very low loadings of P and other functional additives. Herein, we discuss two feasible applications (Figure 1), where biochars, one derived from the pyrolysis of spent coffee grounds and another obtained from the hydrothermal liquefaction (HTL) of civil sludges, are employed as green FRs in aliphatic epoxy-based composites. These biochars can be crucial for the obtainment of self-extinguishing (i.e., no dripping V-0 rating in UL 94 tests) hybrid epoxy materials showing a significant decrease (up to ~65%) in the peak heat release rate, especially in combination with other synergists and sol-gel-derived nanostructures. Part of the research activities concerning the use of biochar from HTL were carried out in the framework of two ongoing projects.

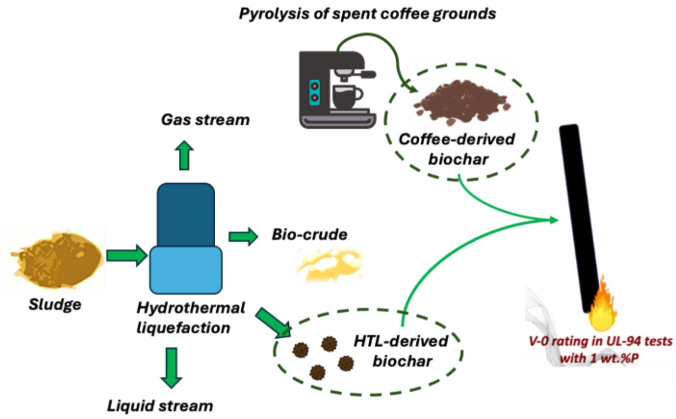

Figure 1: Sol-gel approaches for the preparation of self-extinguishing hybrid epoxy composites

Solution space analysis for robust conceptual design solutions in aeronautics

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Abstract: The use of novel technologies for low-emission and more efficient aviation requires not only the achievement of a given technology readiness level, but also their integration into potentially new aircraft concepts. This also involves ensuring the concept robustness in various flight phases and changing flight conditions. Furthermore, the assessment of a wider spectrum of different and unconventional concepts requires robustness considerations already in the conceptual aircraft design phase. In this context, the present work introduces configuration assessment for various flight conditions or environments, incorporated in the Advanced Morphological Approach (AMA). Currently, the AMA integrates Morphological Analysis and Structured Expert Judgment Elicitation for the purpose of obtaining relevant solution subspaces of aircraft concepts for a given mission. This implies the decomposition of a system into functional or characteristic attributes and their corresponding technological implementation alternatives. These are then evaluated by a selected expert panel, allowing to generate an extensive solution space, which exhibits the concepts' quality for a single flight condition (e.g. cruise flight). The system modeling and evaluation in the AMA can be qualitative or semi-quantitative by using Bayesian inference under uncertainty consideration. The novelty of the approach allows the creation of additional solution spaces reflecting other flight