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Editorial: Development of high-performance resin matrix composites

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Editorial on the Research Topic
Development of high-performance resin matrix composites

1 Introduction

High-performance resin matrix composites have a far-reaching influence on the development of high-technology-intensive fields, such as aviation and aerospace. In the Research Topic "*Development of High-Performance Resin Matrix Composites*", we focus on the progress in the design, preparation, application, and simulation of high-performance resin matrix composites, especially concerning the aerospace field. Seven articles are presented and are divided into three themes: 1) composites for the aerostat envelope; 2) flexible composite tanks; and 3) carbon fiber-reinforced polymer composites.

2 Composites for the aerostat envelope

Lighter-than-air aerostats, such as tethered balloons and stratospheric airships, serve as strategic equipment for reconnaissance, ocean observations, meteorological research, geological mapping, and environmental protection, which are of great importance. The envelope materials for aerostats, which require low density, high strength, excellent weathering, low helium permeability, a good stitching process, easy repair, *etc.*, are of vital significance due to the complex and changeable, and even harsh, working conditions. To satisfy these requirements, envelope materials for aerostats are laminates typically designed with a heat-sealing layer, a load-carrying layer made of fabric, a gas-barrier layer, a weathering layer, and adhesive layers. Song et al. applied equivalent TNT computational modeling, including Brode, Brown, and Crowl, to calculate the overpressure of the shock from this airship envelope explosion, and the effect of geometric scale ratio, pressure difference, and the gas of the explosion overpressure was discussed. The experimental result showed that a computational model based on Crowl's equation was more accurate than the other two. This study can provide a calculation method for overpressure for ground explosion testing of airship envelopes for safe operation. It provides a relatively effective calculation method for shock wave and explosion energy in the event of an airship explosion during a possible accident in flight.

One article investigated the performance of several naturally aged envelope materials in Hainan, China, through numerous tests. The results showed that the outer layer plays a very important role in the properties of envelope materials; PVF and PVDF were better candidates for the weathering layer than TPU and aluminum when working along the coast. This study provides theoretical guidance for structure design and the screening of envelope materials for aerostats used along coasts.

Xiong et al. focused on the repairing ability of envelope materials and synthesized self-healing polycarbonate-based polyurethane (PCU)/polypyrrole nanoparticle (PPy) composites to solve the unavoidable damage to the surface of PCU. The healing process of the fixed area could be finished within minutes through NIR light irradiation, without damaging other areas. Additionally, the mechanical properties and gas barrier property could be restored to near original levels. Furthermore, the PCU/PPy composites showed improved thermal stability and outstanding UV shielding performance. The prepared composites show promising applications in the aerospace domain.

3 Flexible composite tank

A flexible composite tank is developed for the storage of oil and gas, much like the envelope materials used in airships. The tank is made of coated fabric, which is a thermoplastic polyurethane-reinforced aramid fiber, to satisfy strength, sealing, and fluid compatibility requirements. Liu et al. proposed a thermal insulation system for a new flexible composite tank. They investigated two heat-tracing layout methods. Plan 1 involved a full coverage layout along the center pipe and plan 2 involved a layout within 0.5 m height from the bottom of the center pipe. The test results showed that plan 2 is superior to plan 1 in terms of heating efficiency, heating effect, and thermal insulation control. This research provided a cost-effective and convenient thermal insulation solution for avoiding impurity precipitation and the formation of wax plugs caused by extremely low temperatures during mining, transportation, and the storage of oil.

Meanwhile, Liu et al. group also conducted an experimental assessment and numerical simulation of the large deformation of a flexible composite tank. The experimental tests were conducted on two prototypes of 0.4 m in height and a prototype of 1.7 m in height in a water basin. The deformation process was also simulated using a finite element analysis (FEA) model. The results show that the deformation shape of the tank was simulated effectively compared with that in the experimental results. The FEA results were conservative compared with the test results, given that the tank deformation was irregular and the maximum strain was difficult to record during the test. This research provides insight into the deformation behavior of a flexible tank, and the validated FEA model can be used for future design optimization.

4 Carbon fiber-reinforced polymer composites

There is a research article and a review article about carbon fiber-reinforced polymer composites. Carbon fiber-reinforced polymer composites (CFRPs) have excellent properties, e.g., low density, high-temperature resistance, high specific modulus, and high specific strength, and are widely used in aerospace and civil industries. Wu et al. proposed a facile yet efficient strategy for recycling carbon fibers from cross-linked epoxy composites to address the intractable disposal problems in their life cycles. They synthesized cross-linked epoxy composites using diglycidyl ester of aliphatic cyclo (DGEAC), methylhexahydrophthalic anhydride (MHHPA), and T300 woven carbon fiber, and named it CF/DGEAC/MHHPA. The carbon fiber can be recycled through the degradation of DGEAC/MHHPA networks with 1,5,7-triazabicyclo [4.4.0]dec-5-ene (TBD) as a catalyst. Liu et al. summarized the recent advances in interface microscopic characterization of CFRPs, including SEM, TEM, AFM, XPS, Raman, nanoindentation, and other advanced analytical characterization techniques, as well as the application of newly developed microscopic *in situ* mechanical testing methods in the interface characterization, and the trend of interface microscopic characterization technology of CFRPs has also been prospected.

5 Conclusion

In summary, the Research Topic "*Development of High-Performance Resin Matrix Composites*" presents articles on different types of high-performance composites for envelope materials, flexible composite tanks, and CFRPs through multiple perspectives. These articles describe advances in simulation and experiments regarding the physical properties of airships and composite tanks, as well as the recycling strategy and characterizations of CF in cross-linked matrices.

Author contributions

YZ, XL, WL, and KL wrote the article. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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