Chapter

Introductory Chapter: Next-Generation Fibre-Reinforced Composites

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1. Introduction

Composite materials are materials with new properties composed of two or more materials with different properties by physical or chemical methods on a macroscopic scale [1–3]. The comprehensive performance of composite materials is better than that of the original constituent materials, thus meeting a variety of different requirements. The history of the use of composite materials can be traced back to ancient times. From ancient times to the present day, the straw reinforced clay and the steel reinforced concrete are made of two kinds of materials. In the mid-1960s, the carbon fibre-reinforced composite materials appear; in the early 1970s, the composites began to be used in aircraft structures. Compared with traditional materials, composite materials possess high specific strength and modulus, good fatigue resistance, designability and other characteristics. The number of applications in aircraft structures has been rising, the amount of composite materials in the Airbus A350 aircraft has been close to 40% of the total mass of the fuselage, and the Boeing 787 wing and fuselage use more than 50% of the composite materials [4, 5].

2. Characteristics of next-generation fibre-reinforced composites

For the next generation fibre-reinforced matrix composite, the composites should possess higher mechanical properties, that are modulus, strength, high delamination resistance and lower cost, especially for the reinforcing fibres. For the composites used in the high-temperature environment, the composites should possess high mechanical properties at elevated temperatures. Ceramic-matrix composites (CMCs) have a high specific strength, high specific modulus, low thermal expansion coefficient, high resistance to ablation, fatigue, creep, etc. They are new lightweight composite materials that combine structural load bearing and resistance to harsh environments. It has great potential for application in high-temperature structural components, such as thermal protection systems (TPS), for aerospace vehicles (ASV), aero engines, rocket engines and advanced nuclear energy [6]. To ensure the operation reliability and safety of composite structures, it is necessary to perform experimental and theoretical investigation on the design and mechanical properties evaluation of the composites.

3. Summary and conclusions

For the next generation of fibre-reinforced composites, the composites should possess higher mechanical properties that are modulus, strength, fatigue or creep lifetime and lower manufacturing cost. For the composites applied for the high-temperature condition, the composites should possess higher mechanical properties at elevated temperature and improve the fatigue or creep lifetime at elevated temperature.

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