Module 1 Introduction

Unit 1 Evolution of Aviation Materials

The History of Aviation Materials

The History of Aviation Materials

"A generation material, a generation aircraft." shows how aviation keeps advancing. Wood and cloth gave us early flights. Then, aluminum made planes faster. Now, carbon fibre and other advanced materials are making planes even better. Each new material helps create new aircraft, letting us fly higher, faster, and more efficiently. Aviation keeps evolving, thanks to these groundbreaking materials.

Objectives

- *To know the history of aviation materials*
- *To master the key words and expressions of evolution of aviation materials*
- *To understand the common negative prefixes*
- *To cultivate students' self-confidence in aviation materials culture*

Part Ⅰ Lead-in

Task 1 Combine the given words or phrases into one or two sentences, adding some parts of sentence if necessary

(1) Feng Ru; the father of China's aviation; China's first aircraft designer, manufacturer and aviator

(2) the first airplane; be made of; wood frame; fabric

(3) C919; large passenger aircraft; China's first homegrown large jetliner; the main materials; aluminum alloy; high-strength carbon fibre composite materials

Part Ⅱ Reading

课文译文

Evolution of Aviation Materials

"A generation material, a generation aircraft." To some extent, the development of aviation material determines the development of aviation industry. Performance improvement, that is, higher structural efficiency, depends on material selection and processing. The main driving force in aircraft structural design and aerospace material development is weight reduction. In general, materials with high stiffness, high strength, and light weight are most suitable for aircraft applications. Aircraft structure materials have experienced four stages of development, and now it is on the fifth stage. The five stages are:

- ★ The first stage (1903–1919): wood, fabric.
- ★ The second stage (1920–1949): aluminum, steel.
- ★ The third stage (1950–1969): aluminum, titanium, steel.
- ★ The fourth stage (1970–early 21st century): aluminum, titanium, steel, composite material(mainly aluminum).
- ★ The fifth stage (early 21st century–): composite materials, aluminum, titanium, steel (mainly composite materials).

With the development of aircraft, the amount of various materials on the aircraft frame is constantly changing, and the general trend is that the amount of composite materials and titanium alloys is gradually increasing.

In 1903, the Wright Brothers succeeded in creating the first powered aircraft in human history. It was made of wood frame, fabric and wire bracing. Wood frame accounts for 47% of the whole weight of aircraft. That's to say, the main materials of the first airplane were wood

and fabric.

To make the plane stronger and more reliable, metal was used in airframe construction. In 1915, Junkers J-1 flew successfully. It was recognized as the first all-metal aircraft in the world. The main materials used to build the aircraft were iron and steel.

Because of the high density of steel, it is not practical to extensive use on aircraft. In order to obtain weight reduction, An aluminum alloy was developed. Aluminum alloy is lighter and more corrosion-resistant than iron and steel, which was the most suitable materials for aviation at that time. The chief limitation of it is low melting temperature. Light aluminum monocoque structure came into use as load bearing structure in the early 1930s. During 1956 to 1969, titanium alloys were developed to overcome the high temperature intolerance of aluminum and the heavy weight of steel. Because titanium alloys are stronger and harder than aluminum, they are widely used in many high-temperature component structures, such as landing gears and joints. By the 1950s, the transition to the full metal airplane had been completed.

From 1970 to the present, composite materials have become a new member in the family of aeronautical structural materials. The Boeing 747 has over 10,000 surface sq.ft. of fibreglass composite structure. The Boeing 777 used carbon composites for the empennage and floor beams, and flaps as primary structures. The airplane structure utilizes advanced composite materials for their high strength-to-weight properties. As much as 25% weight savings have been realized on airplane components by using composite materials. The composite materials on the airplane consist of graphite, fibreglass or aramid Kevlar fibres, woven into a fabric form and pre-impregnated with a partially cured resin. When combined with Nomex honeycomb core material and fully cured, a high strength, high stiffness, and low weight structure results. Wing leading and trailing edge panels, control surfaces and wing-to-body fairings are constructed in this way. Panel edge bands and control surface spar and rib chords are constructed from laminate materials with no core.

With the development of technology, many smart materials are emerging, such as nanometer materials, self-healing materials, microlattice etc. We are sure that more and more new materials will be used in aviation industry.

Words and Expressions

evolution [ˌiːvəˈluːʃən] *n.* 进化；逐步发展；演化；演变
aviation [ˌeɪvɪˈeɪʃn] *n.* 航空
fabric [ˈfæbrɪk] *n.* 织物；布料
aluminum [əˈluːmɪnəm] *n.* 铝（化学元素）
alloy [ˈælɔɪ] *n.* 合金 *v.* 铸成合金
titanium [taɪˈteɪnɪəm] *n.* 钛（化学元素）
graphite [ˈgræfaɪt] *n.* 石墨
fibreglass ['faibərglɑːs] *n.* 玻璃纤维
Kevlar [kevlɑː(r)] *n.* 凯夫拉
resin [ˈrezɪn] *n.* 树脂
nanometer [ˈneɪnəmiːtə] *n.* 纳米
self-healing [self ˈhiːlɪŋ] *adj.* 自恢复性能的（自行净化的）
microlattice [ˈmaɪkrəʊlætɪs] *n.* 微格金属，微晶格
pre-impregnated 预浸渍的
corrosion-resistant 耐腐蚀
load bearing structure 承重结构
strength-to-weight 强度与重量之比，比强度

单词及短语音频

Task 2 Read the above passage and finish the exercises

1. Read the above passage quickly and answer the questions below.

(1) How many stages has the development of aviation materials gone through? What are they?

(2) Why are the advanced composite materials widely used in aircraft applications?

(3) How to understand "a generation material, a generation aircraft"?

2. Match the words or phrases on the left with the equivalent Chinese on the right.

(1) (　　) weight reduction	A 航空材料
(2) (　　) strength-to-weight	B 减重
(3) (　　) landing gear	C 耐腐蚀
(4) (　　) aviation materials	D 承重结构
(5) (　　) load bearing structure	E 铝合金
(6) (　　) honeycomb core	F 高温
(7) (　　) high temperature	G 高强度
(8) (　　) aluminum alloy	H 比强度
(9) (　　) corrosion-resistant	I 起落架
(10) (　　) high strength	J 蜂窝芯

3. Fill in the blanks with the proper words given below, changing the form if necessary.

driving force　　alloy　　fibreglass　　strength　　titanium

(1) The windows all changed into the aluminum _____.

(2) The main _____ in aircraft structural design and aerospace material development is weight reduction.

(3) _____ alloys are stronger and harder than aluminum, they are widely used in many high-temperature component structures.

(4) A composite rod is built with both graphite and _____ materials.

(5) In general, materials with high stiffness, high _____, and light weight are most suitable for aircraft applications.

4. Choose the best answer and write down their corresponding letter A, B, C or D in the bracket.

(1) What was the earliest airframe made of ? (　　)

A. Wood frames.　　B. Metal frames.

C. Composite materials.　　D. Light aluminum.

(2) When did light aluminum monocoque structure come into use as load bearing structure? (　　)

A. In the early 1920s. B. In 1915.

C. In the early 1930s. D. From 1970.

(3) Compared with titanium, which of the following is the DISADVANAGE of aluminum in building aircraft components? ( )

A. Light weight. B. Low melting point.

C. High melting point. D. Low density.

(4) How many square feet of fibreglass are used in Boeing 747? ( )

A. Less than 10,000. B. More than 10,000.

C. More than 1,000. D. Over 1,000.

(5)Which of the following is NOT the smart materials? ( )

A. Nanometer materials. B. Self-healing materials.

C. Microlattice. D. Stainless steel.

5. Translate the following sentences into Chinese.

(1) In general, materials with high stiffness, high strength, and light weight are most suitable for aircraft applications.

(2) The main materials of the first airplane were wood and fabric.

(3) The Boeing 777 used carbon composites for the empennage and floor beams, and flaps as primary structures.

(4) The airplane structure utilizes advanced composite materials for their high strength-to-weight properties.

(5) As much as 25% weight savings have been realized on airplane components by using composite materials.

Task 3 Read the following Composite Chronology and finish the exercises

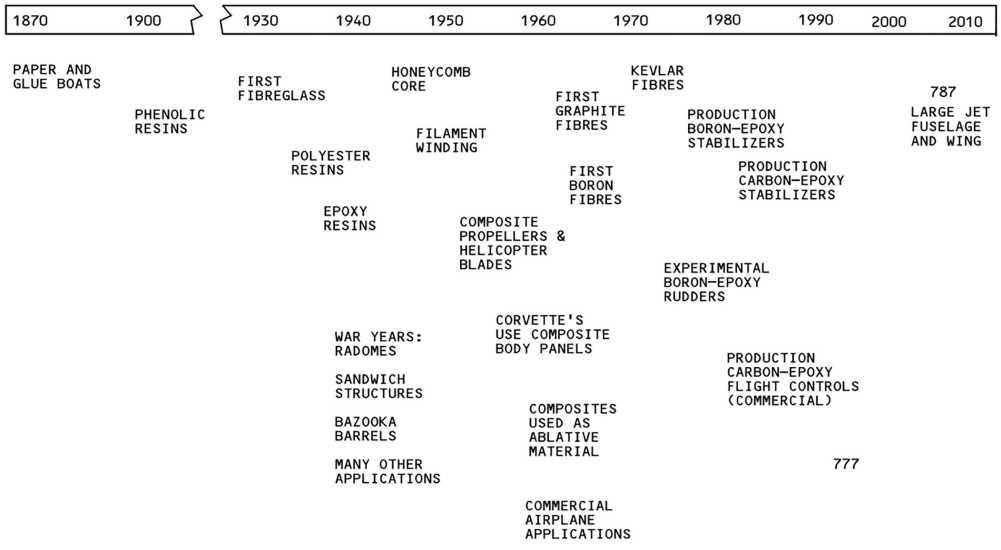

Fig. 1-1 Composite Chronology

1. Translate the following phrases into Chinese.

(1) commercial airplane

(2) boron fibres

(3) flight control

(4) helicopter blade

(5) sandwich structure

2. Judge whether the following statements are true(T) or false(F).

(1) The time of using Kevlar fibre was much earlier than that of fibreglass in aircraft applications. ( )

(2) In 1870, paper and glue were the main materials used in building boats. ( )

(3) During World War II, some fighter radomes were made of composite materials. ( )

(4) Polyester resin was first used in the aircraft manufacturing industry in the early 20th century. ( )

(5) In the late 1980s, carbon-epoxy stabilizer was introduced. ( )

Part Ⅲ Listening

Task 4 Listen and complete

1. Listen to five phrases and choose their Chinese translations.

第 1 题音频

(1)_____ A 硬壳式结构

(2)_____ B 高温部件

(3)_____ C 减重

(4)_____ D 纳米材料

(5)_____ E 航空材料

2. Listen to the short passage twice and put back the missing words in the blanks during the second listening.

第 2 题音频

The main difference between (1) _____ structures and civil engineering structures lies in their weight. The main driving force in aircraft structural design and aerospace (2) _____ development is weight reduction.

In general, materials with high stiffness, high (3) _____, and light weight are most suitable for aircraft applications. Since the first powered flight, aircraft designers have worked to achieve minimum weight in the airframe and engine systems. The first significant use of composite material in a commercial aircraft was by Airbus in (4) _____ in the rudder of A300 and A310. After that more than 2,000 metal parts have been (5) _____ with fewer than 100 composite parts to reduce its weight and production costs.