

Structure Analysis And Choosing Materials for The Aerospace Multi-functional Structure of Electronic Equipment

Yan Zhang¹, Wenyi Liu²

¹ North University of China, Taiyuan City, ShanXi Province, China ; [email:ilyzy99@163.com](mailto:ilyzy99@163.com)

² Electronic Measurement Technology Key Laboratory of State ;
TaiYuan city , ShanXi Province China; [email:liuwenyi@nuc.edu.cn](mailto:liuwenyi@nuc.edu.cn)

Abstract. This article described outline of the external structure for the designing of multi-functional structure of aerospace electronic equipment .And doing analysis for the packaging materials which can be used at home and abroad for its shell structure .And study the application of the composite material (mainly carbon fiber and epoxy resin) on spacecraft multi-functional structure in recent years. Initially set the external structure for multi-functional structure of aerospace electronic equipment and selected some materials which can be used for it.

Key words: Multi-functional structure; aerospace; electronic Equipment; electromagnetic shielding;

1. Introduction

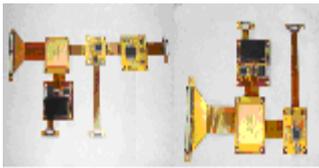
To achieve that the quality, size and life-cycle costs lower than the current one order of magnitude, And to achieve a deeper level of technical breakthroughs in the aspect of the light of small and medium-sized and low power consumption .Fully embodies the "faster, better, cheaper" principle .The above two items are the development of aerospace technology strategic goals in the 21st century. Micro-spacecraft relative to the current spacecraft flight systems in the quality has reduced an order of magnitude, but did not reduce the parasitic quality that relative to the aviation-related electronic equipment chassis, cables, packaging and other structural support or that the connector associated with These parasitic components accounting for the quality of the quality of space spacecraft about 50%[1]. Multifunctional structures (MFS) is based on microelectronic technology, large-scale, ultra-large-scale integrated circuits and high-density interconnect (HDI), Surface Mount Technology (SMT) and the corresponding new methods, new technology-based, multi-chip module (MCM)-based electronic devices, as well as passive electronic circuits, cables, connectors, casing, frame, thermal control, packaging and other accessories for maximum integration, And make the Circuit function modules embed into the structure of composite materials; the structure of the surface is the installation and connection part for the sensors and active electronic circuit.

It is a light and small structure that makes miniature electronic devices into a set machine, which is an integration of mechanism, electricity, heat and a combination of signal processing, data transmission, power distribution, thermal control, electromagnetic shielding, and some other functions.

2. Multi-functional Structure of Electronic Equipment

This study started from the multi-functional structure of the flexible circuit board part [Figure 1]. We used the composite materials panels that commonly used in present life as the initial appearance package for the shielding shell and protective layer of electronic equipment .Cellular structural elements made by light metal or composite materials, is used as thermal conductivity devices which embedded in the structure of composite materials panel by electronic devices , considering from thermal effects. Multi-functional structure is a multi-layer structure, in general, can be divided into 3-4 layers. Top-level composite panels are made to protect the entire structure as the shielding layer .Under the shielding layer is the flexible circuit

board [picture1] formation of multi-chip module (MCM) and circuit. In addition, to replace the cables, connectors and other connectivity equipment are copper polyimide overlapped film. The part supporting the entire structure is the integrated thermal control composite laminate structure at the bottom and its embedded honeycomb structure, used to optimize the thermal situation of entire structure.



picture1
formation of multi-chip module

In space applications, composite materials are essential. Because the use of low-density matrix, if we use the composite materials made of the high concentration and high-modulus fiber, it will make effective weight reduction.

Composite materials Has the following advantages: high-intensity coefficient (the intensity of unit weight), high hardness, corrosion resistance and high fatigue. The MFS panels that used in the SPACE1 are assembled from three composite panels -- K13C2U. Signal-regulated Connect-chip generated voltage distribution for the production of 32 kinds of different DC voltage level used as the A / D converter [2].

2.1 Composite Panel (Shielding Layer)

This layer structure whose primary function is that protecting the MCM module of flexible circuit boards and circuit board. As well as shielding external electromagnetic interference. It can be from 3-4 parts: composite film layer, the metal shielding layer, insulation layer, the battery layer (as the equipment may be). Multi-functional structure of equipment, the protection panel (thin copper / poly imide phthalocyanine (Cu / PI) slab) is used of adhesive bonding to the structure of composite materials panel.

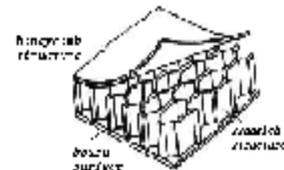
2.2 Flexible Circuit Boards (Including MCM Module)

Flexible circuit board layer mainly formed by circuit board layer, MCM modules, each copper polyimide overlapped film. The circuit board constituted of inner layer board and its components with the shielding layer. Via hot-pressing reinforced laminates on both sides of the inner board, and then hot-pressing shield outside the reinforcement and then combine them. MCM multi-chip module using a special line kovar alloy shell, sealed by the way of high reliability parallel seam welding process, availability of good air tightness and thermal matching, and has anti-interference. MCM directly installed in the panel. Through a thermal interface structure buffers .This close contact with the underlying structure provided a good mechanical properties and overall thermal control.

2.3 The Thermal Control Composite Laminate Panels

This layer is the part supporting the whole structure, but also the main structural elements of the heat emission. This layer can be designed into honeycomb-like structure of metallic materials that has good heat emission property. Honeycomb sandwich structures are from the upper and lower composite panels of high-strength and high toughness and holding a layer of thick, light between the core layers composed of folders. We usually use the adhesive boning the upper and lower panels and the core subsamples as rigid structure, as a whole. Or direct injection or molded sandwich structure to obtain. Honeycomb structure generally as right follow :

3. Selecting Electronic Equipment Packaging Materials for Multi-functional Structure

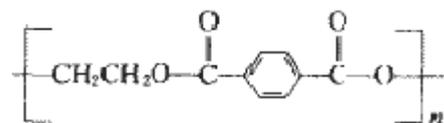


The focus of Multi-functional structure of the study is how to embed the integrated circuits into a laminated composite material panel structure, searching for the structural materials of high specific strength and high specific stiffness for spacecraft structural design are the key points.

3.1 General Materials Film Panels [3]

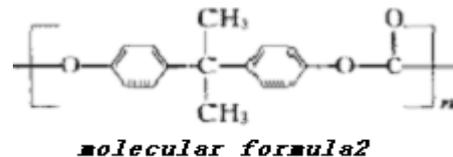
PET: polyethylene terephthalate (Polt Entylene Tere Phthalate, referred to as PET), are from terephthalic acid and ethylene glycol dimethyl ester exchange or firstly terephthalic acid and ethylene glycol through esterification Synthesize terephthalic acid dual-hydroxyethyl methacrylate, and then to carry out polycondensation reaction. Molecular formular as :

[molecular formula1]



molecular formula1

Polycarbonate (Poly Carbonate, short for PC): polycarbonate (bisphenol A-type) chemical name 2,2 - bis (4 - hydroxyphenyl) propane polycarbonate, are from the ester-exchange and the Phosgenation . Molecular formula as: [molecular formula2]



Lightweight materials have silicon carbide, silicon aerogels and inflatable structures used in thin film materials, CVD and PVD TiN, TiC, TiCN, TiAlN hard films such as coating material also has been widely applied, but still can not meet much difficulty processing materials, such as high-silicon aluminum alloy, various non-ferrous metals and alloys, engineering plastics, non-metallic materials, ceramics, composite materials (especially metal matrix and ceramic matrix composites), such as processing requirements these demands promote the new superhard thin films Materials Research Progress ,such as research on diamond membrane, cubic boron nitride (c-BN) and carbon and nitrogen membrane (CNx), nanocomposite thin films etc..

3. 2 Analysis of Composite Materials

3. 2. 1 Carbon Fiber

Composite fiber-reinforced materials is in the most widely used and used to the maximum. Its characteristics are the small proportion and large specific strength and modulus .Carbon fibers are fibrous carbon materials, carbon content is more than 90%. There are very good mechanical properties, compared with other high performance fibers, it has the highest strength and highest modulus. In an inert environment of High temperature above 2000 °C, is the only material whose strength don't decreased. Since the mid-80s, the carbon fiber development developed fiercely, performance levels increased rapidly .From the initial tensile strength of 2.5GPa improved to the current 7.0GPa, and has excellent surface treatment agent and the resin matrix matching. intensity, the conversion rate improved to 85 ~ 95, the application of carbon fiber make the shell strength and stiffness greatly changed, and mass production makes the price of carbon fiber with a sharp fall in [4], Table 1 shows the selected materials and part of their parameters which used in experimental process of the study.

Table 1 The materials been selected and their key parameters

Name	Manufacturer	Tensile modulus (Gpa)	Thermal conductivity (W/m.k)	Density (g/cm ³)
T300	Toray	230		1.76
M40J	Toray	372	~40	1.77
K13B2U	Mitsubishi	827	260	2.16
K13C2U	Mitsubishi	900	620	2.2
K13D2U	Mitsubishi	930	800	2.2
YSH-70A	NGF	724	250	2.16
YS-90A	NGF	896	430	2.19
YS-95A	NGF	924	600	2.19
R-120S	CYTEC	828	600	2.16
K800	CYTEC	896	800	2.2
K1100	CYTEC	931	1000	2.2

3. 2. 2 Epoxy Resin

Epoxy resin is a generalization of compounds that in its molecule contains two or more epoxy group. For decades it has been the main body of the resin matrix composite material .used in rocket motor casing . All these years has gone through rigid epoxy - Flexible Epoxy - rigid epoxy Rethinking the process, but the UN has been the dominant rigid bisphenol A diglycidyl ether epoxy mixture .The inherent disadvantage of epoxy resins is

weak on resisting impact damage. Heat resistance is also low (less than 170 °C), rocket motors flight under high-speed, the insulation of outer surface must be good to guard against the impact of aerodynamic heating, so it increased the inertia quality of the engine. 4,4 '- diamino diphenylmethane four glycidyl amine (TGDDM), in view of cost effectiveness, maybe it is the most practical high-performance epoxy resin.TDE-85 epoxy resin of the three functional groups, the chemical known as 4, 5 - epoxy hexane -1,2 - dimethoxy diethyl glycidyl, the molecule contains two glycidyl Reactivity-based of high reactivity and a alicyclic epoxy group difference with the former. The usability and heat resistance of it are very good, and it is a high-performance epoxy resin [5].

3. 2. 3 Carbon Fiber and Epoxy Resin Composite

Carbon fiber and epoxy resin composite material, its specific strength and specific modulus are larger several times than steel and aluminum alloy ,and also has an excellent chemical stability, anti-friction wear-resistant, self-lubricating, heat resistance, fatigue resistance, creep change, muffler, electric insulation

properties, and can achieve excellent thermal conductivity and low coefficient of thermal expansion. T300 carbon fiber / resin matrix composite materials in aircraft has been widely used as structural materials, the current application for more whose tensile strength reached 5.5GPa, the high-strength modulus carbon fiber T800H fiber owned about 30 percent higher fracture strain than T300 carbon fiber .Carbon fiber / epoxy and carbon fiber / BMI composite materials used in aircraft fuselage, main wings, vertical tail, flat tail and skin, such as location, has played an obvious role in weight loss, greatly improve the anti-fatigue, corrosion-resistant properties. This value is the main reference direction why choosing these materials in this study.

Multi-functional structure of electronic equipment selected composite materials can not only play a role in weight loss, but also can improve the anti-fatigue, resistance to corrosion of the entire equipment.

3. 3 Applications Of Composite Materials In Rocket And Missile

The high-performance carbon (graphite) fiber composite materials is a typical representative of the advanced composite materials as structural, functional or structural / functional integration of component materials, mainly used in missile warheads, missile and rocket engine components and the shell structure of the main satellite Structural load-bearing parts.

The carbon / carbon and carbon / phenolic end are warhead and engine nozzle throat insert and ablation and other important components of heat-resistant materials, the United States dwarf, the militia and Trident strategic missiles have been the application of sophisticated.United States, Japan, France, mainly use carbon fiber composite materials to be solid rocket motor shell ,such as the United States Trident missiles -2, Tomahawk cruise missile, a Titan 4 rocket 1, Japan's M -5 rocket, such as engine Shell, which is the biggest use of 5.3GPa tensile strength of the IM-7 carbon fiber produced by the United States Hercules company, the highest performance are Toray T-800 fiber, the tensile strength 5.65Gpa, Young's modulus of 300GPa. A new material, called a new type of cellulose RaycarbC2TM carbon cloth, The carbon cloth / phenolic composite material has been used successfully on Arianna V Flight164 flight [4].

4. Conclusion

Through analyzing the situation of using composite materials in domestic and foreign, this study laid emphasis on the case that the large-scale spacecraft using the composite materials as structural and function integration materials. The design of Multi-functional structure of electronic equipment will select the following materials:

- Shielding layer consisted of:

Complex thin film materials: polyester, polycarbonate, epoxy resin / carbon fiber composite (T700 / TDE-85) etc; Metal shield protective coating: copper, aluminum etc;Insulating layer: silica gel, silica gel etc.

- Flexible circuit board layer consisted of

Circuit board: Copper Polyimide resin ;Lapping film: copper and polyimide resin

- Thermal control composite laminate

Upper and lower panel: epoxy / carbon fiber composite (such as T700 / TDE-85) etc.

Honeycomb sandwich: a variety of fibers such as glass fiber, carbon fiber, aromatic amine phthalocyanine poly fiber (such as Kevlar), paper, cotton cloth, impregnated resin on the above materials ,and then through the bonding tensile or bellows-shaped bonding pressure to get it.

5. References

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