generally been the case that, when a complex shape is required, the metal material is processed to the desired shape in advance through press molding or punch molding before it is integrated with the fiber-reinforced resin (patent documents 6 and 7).

[0007]

Furthermore, since such electronic equipment chassis require a resin layer aimed at providing bonding, there is deficiency in the amenability to thin-wall design and degree of design freedom, and this has given rise to the problem of undermining the ongoing efforts to reduce the weight of electronic equipment. There is another problem in that, since separate processing steps are required for the metal material and fiber-reinforced resin, the production cost of chassis is high due to a need for a large amount of production equipment needed.

Prior art documents

Patent documents

[0008]

Patent document 1: JP 2006-297929 A

Patent document 2: JP 2010-131789 A

Patent document 3: JP 2005-161852 A

Patent document 4: JP 2006-123209 A

Patent document 5: JP 2009-045129 A

Patent document 6: JP 2001-298277 A

Patent document 7: JP 2001-315162 A

Patent document 8: JP 03-177418 A

Patent document 9: JP 03-296525 A

Patent document 10: JP 64-070523 A

Summary ~~of the invention~~

Problems to be solved ~~by the invention~~

[0009]

The task of the present disclosure~~invention~~ is to provide manufacturing methods for metal composites which integrate metal materials together or metal materials and other structural materials via a cured resin layer or layers, which easily achieve an ability to process high-rigidity metal materials with an excellent amenability to thin-walling and lightweighting and a high degree of design freedom into complex shapes and an ability for fast compositing as demanded by the market, and which are able to produce metal composites having excellent bonding strength, as well as electronic equipment chassis that use metal composites obtained through such manufacturing methods.

Means of solving the problems

[0010]

The first aspect of the manufacturing method for metal composites of the present disclosure~~invention~~ is as described below:

[0011]

A method for producing a metal composite which is molded by heating and pressurizing a preform including a sheet substrate containing a thermosetting resin and a metal material disposed in contact with the sheet substrate or laminated therewith to form the metal composite comprising the metal material and a cured resin layer formed by curing the thermosetting resin provided along the metal material, wherein the method comprises:

a step 1 for placing the preform in a mold and heating the metal material to a temperature in excess of 180°C while heating the sheet substrate to semi-cure the thermosetting resin, and

a step 2 for applying a pressure to the preform being heated in the step 1 to form a

composite material; and wherein

the thermosetting resin is at least one selected from the group consisting of epoxy resin, phenol resin, benzoxazine resin and unsaturated polyester resin.

[0012]

The second aspect of the manufacturing method for metal composites of the present disclosure~~invention~~ is as described below:

[0013]

A method for producing a metal composite which is molded by heating and pressurizing a preform including a sheet substrate containing at least one thermosetting resin selected from the group consisting of epoxy resin, phenol resin, benzoxazine resin and unsaturated polyester resin, and a metal material disposed in contact with the sheet substrate or laminated therewith to form the metal composite comprising the metal material and a cured resin layer formed by curing the thermosetting resin provided along the metal material, wherein the method comprises:

a step 1 for placing the preform in a mold and heating the metal material so as to raise its surface temperature in excess of 180°C while semi-curing the thermosetting resin,

a step 2 for applying a pressure to the preform being heated in the step 1 to form the metal composite, and

a step 3 for cooling down the metal composite molded in the step 2 under pressure so as to lower the surface temperature of the metal material to 180 °C or less.

[0014]

In an embodiment~~the second aspect~~, it is preferable that the pressure applied to the metal composite in the step 3 is equal to or larger than the pressure applied to the preform in the step 2.

[0015]

In an embodiment~~the second aspect~~, it is preferable that the time taken by the surface temperature of

the metal material to fall from more than 180 °C to 180 °C or less is 3 minutes or less.

[0016]

In some embodiments~~the first or second aspect~~, it is preferable that the mold has a surface temperature of 200 to 300 °C when the preform is placed in the step 1.

[0017]

The third aspect of the manufacturing method for metal composites of the present disclosure~~invention~~ is as described below.

[0018]

A method for producing a metal composite including a metal material and a cured resin layer provided along the metal material, wherein the method comprises:

a step 1-1 for heating a sheet substrate containing at least one thermosetting resin selected from the group consisting of epoxy resin, phenol resin, benzoxazine resin and unsaturated polyester resin, to semi-cure the thermosetting resin,

a step 1-2 for preheating the metal material to its surface temperature of more than 180 °C but not more than 400 °C, and

a step 2 for placing in contact with each other or laminating the sheet substrate, which has undergone the step 1-1, and the metal material, which has been preheated in the step 1-2, inside a mold having a surface temperature of 180 °C or less and applying a pressure to mold them into the metal composite.

[0019]

In an embodiment~~the third aspect~~, it is preferable that heating in the step 1-1 and heating in the step 1-2 are performed in apparatuses different from each other.

[0020]

In an embodiment~~the third aspect~~, it is preferable that the step 1-1 and the step 1-2 are performed in parallel.

[0021]

In an embodiment~~the third aspect~~, it is preferable that the step 1-1 and the step 1-2 are completed substantially at the same time.

[0022]

In an embodiment~~the third aspect~~, it is preferable that a preform combined the sheet substrate and the metal material is prepared prior to molding the metal composite in the step 2.

[0023]

In some embodiments~~the first, second or third aspect~~, it is preferable that the thermosetting resin contained in the sheet substrate reaches a cured state when heated at 130 °C for 10 minutes.

[0024]

In some embodiments~~the first, second or third aspect~~, it is preferable that the thermosetting resin contains a curing accelerator.

[0025]

In some embodiments~~the first, second or third aspect~~, it is preferable that the preform has a sandwich structure configured by laminating the metal material onto both sides of the sheet substrate or a laminate of such substrates.

[0026]

In some embodiments~~the first, second or third aspect~~, it is preferable that the thermosetting resin reaches a cured state in the step 2 or the step 3.

[0027]

In some embodiments~~the first, second or third aspect~~, it is preferable that an edge of the preform undergoes a hemming or crimping treatment in the step 2 or the sep 3.

[0028]

In some embodiments~~the first, second or third aspect~~, it is preferable that the sheet substrate is a prepreg

obtained by impregnating a fiber base with a thermosetting resin.

[0029]

In some embodiments~~the first, second or third aspect~~, it is preferable that the metal material is a plate body having a thickness of 0.1 to 1 mm.

[0030]

In some embodiments~~the first, second or third aspect~~, it is preferable that the metal material has physically, chemically or electrically undergone surface roughening on a surface thereof that comes in contact with the sheet substrate.

[0031]

In some embodiments~~the first, second or third aspect~~, it is preferable that a surface of the metal material that comes in contact with the sheet substrate has multiple pores 0.01 to 100 μm in size.

[0032]

In some embodiments~~the first, second or third aspect~~, it is preferable that a metal constituting the metal material is at least one selected from the group consisting of an aluminum alloy, magnesium alloy and titanium alloy.

[0033]

In some embodiments~~the first, second or third aspect~~, it is preferable that the bonding strength between the metal material and the cured resin layer in the metal composite to be produced is 10 MPa or more.

[0034]

In a fourth aspect, there is provided an~~The~~ electronic equipment chassis of the invention ~~are~~ as described below:

[0035]

An electronic equipment chassis obtained by integrating a metal composite A that is produced by any of the metal composite manufacturing methods as defined above~~of the present invention~~, and a part B composed of a thermoplastic resin b.

[0036]

It is preferable that, in the electronic equipment chassis, part B is at least one type of shaped part selected from the group consisting of a boss, rib, hinge, frame, keyboard base, vertical wall and seat.

[0037]

It is preferable that, in the electronic equipment chassis, a resin layer C composed of a thermoplastic resin c is formed on a surface of the metal composite A.

[0038]

It is preferable that, in the electronic equipment chassis, the melting point or glass transition temperature of the thermoplastic resin c is lower than that of the thermoplastic resin b.

[0039]

It is preferable that, in the electronic equipment chassis, the pores formed on a surface of the metal material are filled with at least one type of resin selected from the group consisting of the thermosetting resin, thermoplastic resin b and thermoplastic resin c.

[0040]

It is preferable that, in the electronic equipment chassis, the metal composite A is provided with at least one type of shaping treatment selected from the group of tapering, grooving, hole-drilling and match jointing, with the part B joined to the metal composite A by fitting into that shape.

[0041]

It is preferable that, in the electronic equipment chassis, the metal composite A and part B are joined by placing the metal composite A in a mold and injection-molding the part B into it.

Advantageous effects ~~of the invention~~

[0042]

The present disclosure~~invention~~ provides manufacturing methods for metal composites which integrate metal materials together or metal materials and other structural materials via a cured resin layer or layers, which easily achieve an ability to process high-rigidity metal materials having an excellent amenability to thin-walling and lightweighting and a high degree of design freedom into complex shapes and an ability for fast compositing as demanded by the market, and which are able to produce metal composites having excellent bonding strength, as well as electronic equipment chassis that use metal composites obtained through such manufacturing methods. It also provides electronic equipment chassis incorporating an electromagnetic shielding capability and antenna characteristics as required of electronic equipment fitted with telecommunications features.

Brief description of the drawings

[0043]

Figs. 1 (a), 1 (b) and 1 (c) are a set of schematic sectional drawings illustrating the manufacturing procedure for an embodiment of the present invention with regard to manufacturing methods for metal composites.

Fig. 2 is a graph illustrating an example of the relationship between temperature, duration and pressure under a manufacturing method for metal composites of the present invention.

Fig. 3 is a graph illustrating another example of the relationship between temperature, duration and pressure under a manufacturing method for metal composites of the present invention.

Figs. 4 (a-1), 4 (a-2), 4 (b) and 4 (c) are a set of schematic sectional drawings illustrating the manufacturing procedure for another embodiment of the present invention with regard to manufacturing methods for metal composites.