Pitch Based Carbon Fiber Production Process and Properties

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Introduction

Carbon fiber is a lightweight, flexible, high strength, high tensile modulus material produced from polyacrylonitrile (PAN), pitch, or rayon by a series of heating steps. It is used as a material of construction for aircraft, space shuttle, sporting goods, and industrial products where weight savings performance is of primary consideration. Addition to above properties pitch based carbon fiber (PBCF) is arrested attention to its thermal properties.

PBCF production process is consisted of 6 processes, 1) Pitch preparation, 2) Spinning, 3) Thermosetting, 4) Carbonization, 5) Graphitization and 6) Surface Treating.

About ten years ago, we have developed PBCF and its production plant. In this paper, I will explain and discuss many technical and economical problems of each process developing PBCF.

[1] Production Processes of PBCF

[1.1]Pitch preparation

In this process, most important operation is elimination of the impurities, such as solid particles, or gel like materials. Exist of these impurities cause to decrease the tensile strength of the product carbon fiber.

Removing Low Molecular Weight Hydrocarbons (LMWHC) is also very important. The existence of LMWHC makes difficult to spin.

[1.2] Spinning

This spinning process is the most difficult process in the PBCF production processes.

As you know, precursor pitch has 1000 to 1500 molecular weight, which is medium molecular weight polymer. The viscosity of this MMW polymer is sensitive for temperature. So, we need precise temperature control of spinneret and atmosphere of near the spinneret.

Another difficulty of spinning, precursor pitch is very weak, and brittle like the ash of rice straw. So, taking-up and rewinding green fiber (pitch fiber) is very difficult, as we had to find out another way to pull down pitch fiber from spinneret.

[1.3] Thermosetting

This process is one of the most difficult processes. Thermosetting uses oxidation reaction. It is very important to remove heat from pitch fiber. Too fast thermosetting reaction cause to melt the surface of fiber and stick to fiber each other. To avoid this phenomenon we must use slow thermosetting reaction. This is one of the reasons of low productivity of PBCF. In the case of thermosetting pitch fiber, it is unnecessary to use tension, differ from PAN precursor.

[1.4] Carbonization

For the fiber without defects, this carbonization process is very easy one compare with another process mentioned above. Carbonization reaction is very first; it needs only 10 second or less. But there is large difference of tensile strength between thermosetting fiber and carbonized fiber. We need some devices to control tension of carbonizing line.

[1.5] Graphitization

In graphitization process there is large advantage for PBCF. The speed of graphitization reaction of pitch base carbon fiber is faster than that of PAN fiber.

The main problem of this process is consumption of electrode of graphitization furnace. According to rise the graphitization temperature, consume of electrode is increased.

For cost down of graphitization process, we must depress graphitization temperature.

Another cost down way in graphitization process, we save inert gas (argon gas). Under 2,500 degree C, we can use nitrogen gas instead of argon gas.

[2] Properties of PBCF

As mentioned above, PBCFs has superior mechanical and thermal properties, such as Tensile Modules, Minus CTE and Thermal Conductivity.

Fig1 shows Thermal Conductivities of PBCFs and competitive materials.

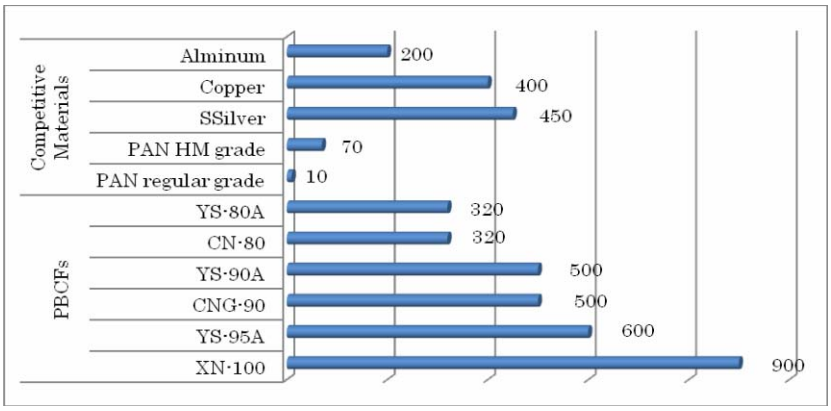


Fig 1 Thermal Conductivities of PBCFs and competitive

Fig 2 shows Zero CTE composite using PBCF.

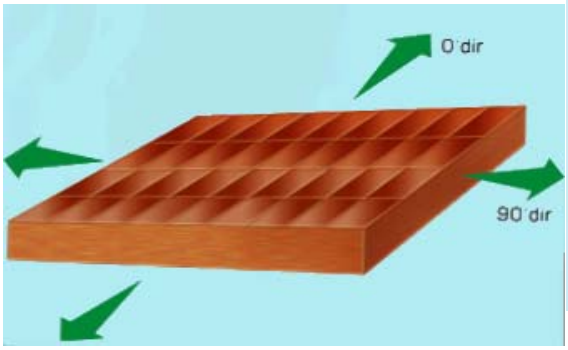
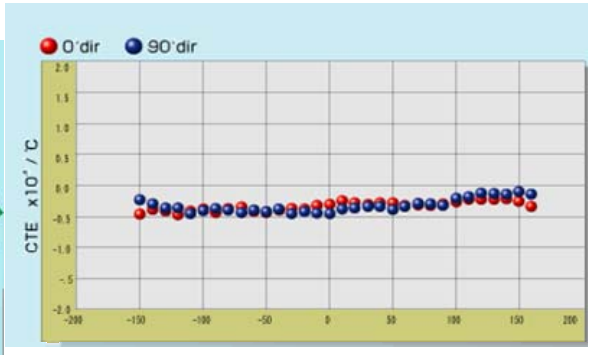


Fig 2 Zero CTE composite using PBCF.



Test temperature °C

CTE of Laminate with PBCF Fabric

Coming seminar, I would like to show more detail information about production processes and properties of PBCFs.