Chapter in Book

Carbon Fiber for Consumer Applications

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Abstract: *One of the newest trends in engineering materials is natural fiber reinforced composites (NFCs). The most important factor in engineering product manufacture is cost effectiveness. These NFCs are favored in most applications because they are less polluting and have a larger fiber content for equal performance, reducing the use of more polluting base polymers. Carbon fiber reinforced composite materials that were developed in the 1950s as a reinforcement for high temperatures molded plastic component on missiles. Carbon fiber were containing 90% from Polyacrylonitrile (PAN) and 10% from Rayon or Petroleum pitch. Carbon fiber is one of the polymers and it is a strong material, but it is lightweight. They were consisting of a thin but strong crystalline filament of carbon. The carbon fiber was made from a process that is a part chemical and part mechanical. The carbon atoms in carbon fiber are bonded together in microscopic crystals. The crystal alignment will make the fiber incredibly strong. Carbon fiber were classified by the tensile modulus of the fiber. Tensile modulus is a measure of how much pulling force a certain diameter fiber can exert without breaking. Carbon fiber always used in part of automobiles, airplanes, and recreational product and because of their unique properties, it is also used to make a phone case.*

Keywords: Mechanical; Carbon fiber; Consumer; Cell phones; Phone case

1. INTRODUCTION

Devices, items, commodities, or merchandise of regular or frequent use that are typically purchased by individuals or households for private consumption from a retail outlet or otherwise received or delivered directly to the consumer are referred to as consumer products. Consumer goods are items purchased by the ordinary person for personal consumption. Consumer products, also known as final goods, are the product of production and manufacturing and are what a customer will see on the store shelf. Consumer goods include things like clothing, food, and jewelry.

One of the newest trends in engineering materials is natural fiber reinforced composites (NFCs). The most important factor in engineering product manufacture is cost-effectiveness. These NFCs are favored in most applications because they are less polluting and have a larger fiber content for equal performance, reducing the use of more polluting base polymers. Carbon fiber reinforced composite materials that were developed in the 1950s as a reinforcement for high temperatures molded plastic components on missiles. Carbon fiber were producing mostly 90% Polyacrylonitrile and 10% Rayon or Petroleum pitch. Carbon fiber is one of the polymers and it is a strong material, but it is lightweight (Chung, 1994). They were consisting of a thin but strong crystalline filament of carbon. The carbon fiber was made from a process that is a part chemical and part mechanical. The carbon atoms in carbon fiber are bonded together in microscopic crystals. The crystal alignment will make the fiber incredibly strong. Carbon fiber were classified by the tensile modulus of the fiber. Tensile modulus is a measure of how much pulling force a certain diameter fiber can exert without breaking (Roberts, 2006). Carbon fiber always used in part of automobiles, airplanes, and recreational product and because of their unique properties, it is also used to make a phone case (Fitzer et al., 1989).

2. THE PAN CARBON FIBER

Current industrial needs are driving research toward techniques that are amenable to integration into continuous processes and the use of modern analytical technology to large-scale manufacturing lines. Microwave heating has a number of advantages over traditional processes. Dehydrogenation time was found to be reduced by up to 50%, while fiber structure was observed to be less faulty due to more uniform heating from the core to the epidermis.

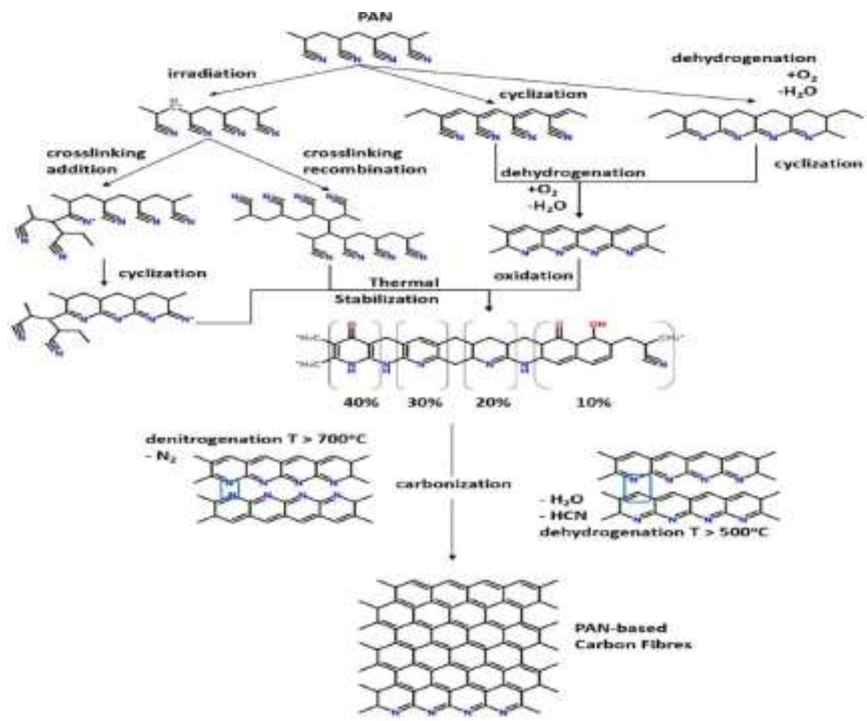

Figure 1. The Process of Making a Carbon Fiber

3. TENSILE PROPERTIES OF STABILIZED PAN FIBERS

To investigate the effect of heat treatment on the mechanical properties of stabilized fibers, tensile tests were performed on heat treated fibers.

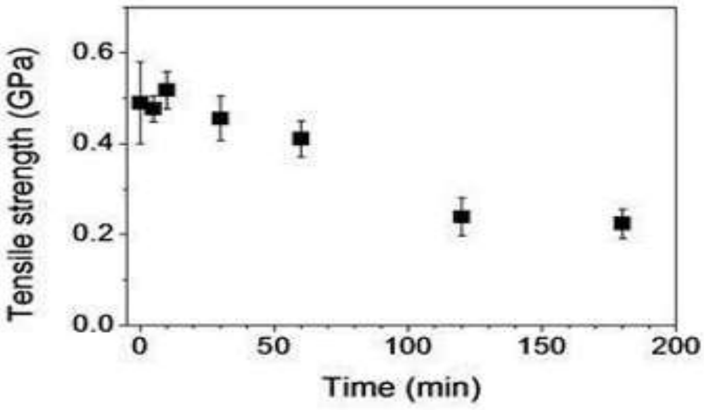

Figure 2. Displays tensile properties of PAN and its stabilized fibers. Tensile strength of PAN fibers without stabilization was ~0.5 GPa

Tensile strength did not change significantly after stabilizing PAN fibers for up to 30 minutes. A further increase in stabilization time resulted in a monotonous decrease intensile strength, with stabilized PAN fibers exhibiting tensile strength of 0.23 GPa after 120 minutes. There was no further decrease discovered.

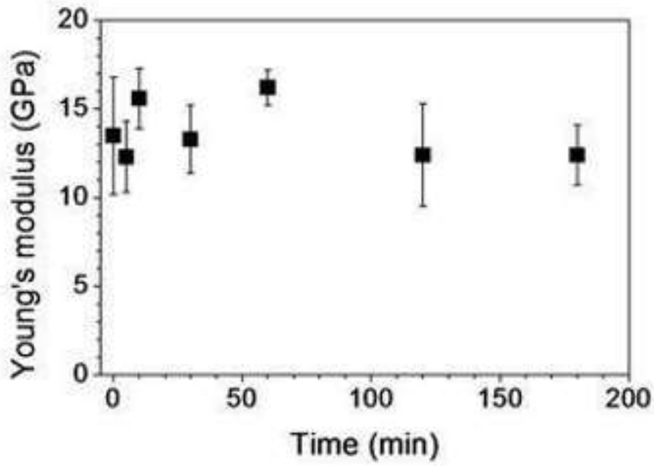

Figure 3. Young Modulus

Tensile moduli for PAN and stabilized fibers are shown in the Figure 3. Tensile modulus did not change significantly as stabilization time increased: 13.5 and 12.4 GPa for PAN and stabilized fibers after 180 minutes, respectively.

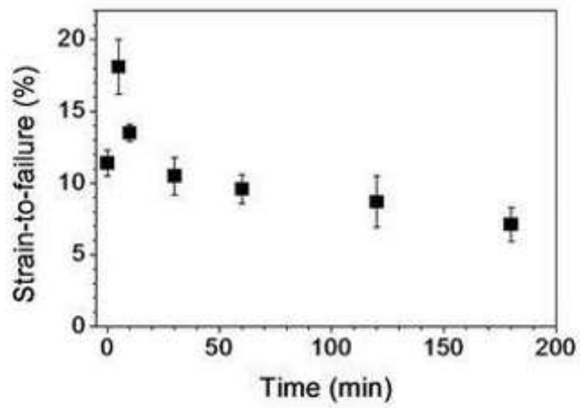

Figure 4. Strain-to-Failure

The strain-to-failure of PAN fibres was found to be 11% in Figure 4, but fibres stabilised for 5 minutes showed a strain-to-failure of 18% due to PAN fibre relaxation during stabilisation even though a constant tension was applied. After 30 minutes of stabilisation, the value was 14 percent. Strain-to-failure was reduced to 7% after 180 minutes of stabilisation.

4. SEM ON PAN CARBON FIBER

The PAN fibers strongly coupled the CF junctions with the pores between the fibers, as seen by scanning electron microscopy. The carbon webs' tensile strength rose as the percentage of PAN fibers employed as the binder increased.

Due to their high carbon yield and melting point, PAN carbon fibers are a well- known precursor for the production of carbon fiber. The precursor PAN fibers are converted to graphitic carbon fibers via a high-temperature thermal treatment. Carbon fibers made from pitch, rayon, and other materials are substantially weaker than carbon fibers made from PAN.

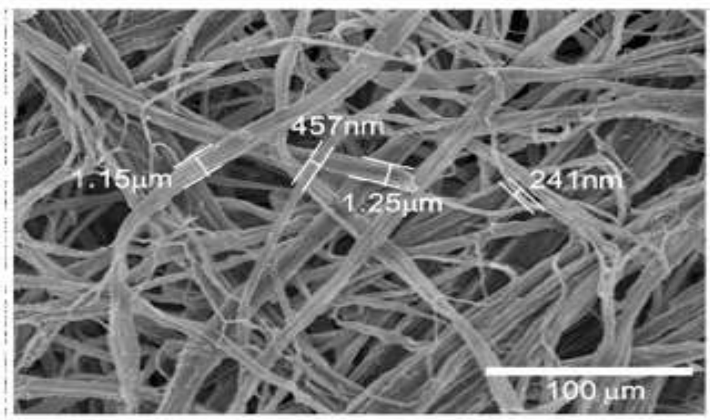

Figure 5. SEM image on Carbon Fiber Car

5. FTIR ANALYSIS OF PAN CARBON FIBER

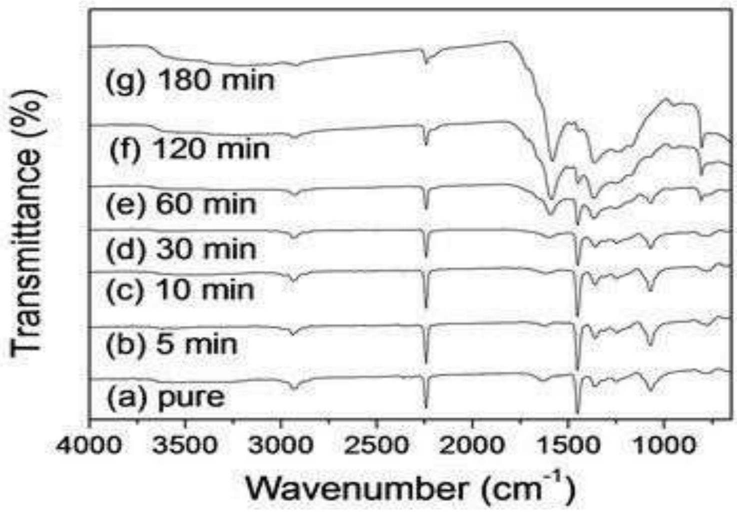

Figure 6. FTIR

Figure 6 depicts the FTIR spectra of PAN fibers before and after stabilization in a convection oven at 250˚C for a variety of times. Prior to stabilization, distinct absorption bands at 2939, 2243, 1454, and 1360 cm^{-1} were assigned to C-H in CH_2, CN in CN, C-H in CH_2, and C-H in CH, respectively in Figure 6(a).

A band at 1071 cm^{-1} was produced by S=O groups of DMSO solvent that remained after spinning. For 5 and 10 minutes, there was no significant difference with stabilized fibers in Figures 6(b) and (c). Stabilized fibers for 30 minutes showed a faint appearance at 1595 cm^{-1} assigned to conjugated C=N stretching in Figure 6(d). After 60 minutes of cyclization and dehydrogenation of fibers, the intensity of a band at 1595 cm^{-1} increased, but the intensities of bands at 2939, 2243, and 1454 cm^{-1} decreased Figure 6(e).

Figure 6(f) shows two shoulders that appeared for 120 minutes at 1710 and 1660 cm^{-1}. Figure 6(g) shows that the band and shoulder are distinct at 2243 and 1454 cm^{-1}, respectively. This demonstrates that even after stabilization for 180 minutes at 250 ˚C, all PAN are not cyclized.

4. CONCLUSION

This review present a future application of carbon fiber for consumer applications. Researchers show a promising properties of the carbon fiber based on tensile test, SEM and FTIR characterization.

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