Improvement of thermal stability of polymeric materials by carbon nanotube as an antioxidant

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Polymers, such as rubbers, thermal plastic elastomer, resins and engineering plastics etc., are widely used as an industrial material because of their excellent properties. However, they are very weak for heat, vapor and UV-irradiate derived by thermal degradation of its main-polymer-chain by auto-oxidation reaction. The low-heat resistance of polymers limits their further wide-range of application. Therefore, improving thermal resistivity of polymers is one of the most important issue in the industrial field.

Thermal resistivity of polymers can be improved in several ways. Attempts to improve the thermal resistivity of polymers by changing and controlling the chemical structure of polymers have been carried out for a long time. However, as these attempts have been exhausted, it is difficult to achieve further improvement in thermal resistivity of polymers.

Another approach to improving the thermal resistivity of polymers is to add additives typified by antioxidants. By quenching and scavenging the radicals generated by thermal decomposition at high temperature, the antioxidant can greatly improve the heat resistance of the polymer material. However, the antioxidant has a problem that the heat resistance of the antioxidant itself is not so high. This is because the conventional antioxidant is low molecular weight, its function is lowered or decreased by heat denaturation at high temperature. Therefore, in order to further improve the thermal resistance of the polymer material, it is necessary to use an antioxidant having higher heat resistance.

Carbon nanotubes (CNT) is a material having a possibility to be used as an antioxidant which can be used under a high temperature environment. CNT has -electrons on its surface, has high thermal resistance (~600^{o}C in air) and is a high aspect ratio of fibrous material with a large specific surface area (~1200 m^2/g), so it has great potential as a high thermal resistive antioxidant.

However, on the other hand, as a weak point of CNT, it contains a metal (normally iron or its alloy) acting as a catalyst at synthesis process, which is a big problem for using CNTs as antioxidant. It is known that a metal catalyst functions as a decomposition catalyst of a polymer material.

Super growth single wall carbon nanotube1 (SG-SWNT) is synthesized by CVD, it does not contain a metal catalyst. Furthermore, because of SG-SWNT is a single wall CNT, it is having a very large specific surface area more than 1000 m^2/g. Therefore, it is expected to be the CNT having the most excellent antioxidant among CNTs.

In this study, we also report the effect of SG-SWNT as an antioxidant to improving thermal resistivity of polymers.

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