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Fatigue Lifetime Prediction of Rubber-Clay Nanocomposites

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Extended Abstract

We developed acrylonitrile butadiene rubber material that is environment-friendly and superior in mechanical property using rubber-clay nanocomposites. Typical modifiers to enhance dynamical properties of rubber material were carbon black and silica. Recently, nano-clay was popular as modifiers. Many researches on nanocomposites are being actively carried out because they are excellent in modification even with a small quantity of them while nano-clay is difficult to diffuse [1].

Fillers or modifiers used when manufacturing polymer nanocomposites include layered silicate, POSS nanoparticles, CNT and nanoparticles of metal or inorganic matters, among which layered silicate is now being most actively developed as polymer nanocomposites. The key technology of development of polymer nanocomposites is how to change layered clay so as to easily insert polymers into it. When organic matters are inserted using inorganic material like clay silicate that has a uniform structure with nano scale, in particular, nanocomposites are attracting great concerns in their application. The basic structure of clay, as it is well known, consists of silica tetrahedral and alumina octahedral sheets: it is classified into several groups including vermiculite and montmorillonite depending on its negative charge.

In this study, acrylonitrile butadiene rubber (NBR) was used as rubber in combination; ZnO and stearic acid were used as vulcanization activators; and 3C was used as an additive; sulfur of purity 99.9% was used as a vulcanizing agent; TT and CZ were used as vulcanization accelerators; and carbon black, clay, and nano-clay were used as reinforced compound. Polymer layered silicate was made by the melted intercalation method in which polymers in the melted state were inserted between silicate layers: this method is advantageous in mass production and does not need to use solution.

Thermal resistance was estimated through material tests of developed material at room temperature and aged condition. Fatigue durability [2] was estimated after we developed a new method [3] that could estimate fatigue lifetime [4, 5] of rubber parts in a short period in the initial stage. As results, fatigue lifetime evaluation by the fatigue lifetime prediction equation was exactly consistent with that obtained by fatigue tests of actual engine mounts. In addition, we verified that the developed material was superior in fatigue durability as well as mechanical properties because the lifetime of rubber component made by the developed material was longer than the existing material.

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