

研究助成 研究成果報告書

平成27年2月28日

公益財団法人 江野科学振興財団
理事長 江野真一郎 殿

貴財団より助成のありました研究の成果について、下記のとおり報告します。

申請者名

Atitaya TOHSAN



記

1.研究課題名

和文	粒状シリカのネットワークスによる天然ゴムの補強効果に関する研究
英文	Study on particulate silica networks in natural rubber from the viewpoint of reinforcing effect

2.申請者名(代表研究者)

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4.英文抄録 (300 語以内)

Novel biphasic structured in situ silica filled natural rubber composites were focused on their strain-induced crystallization (SIC) behavior from the viewpoint of morphology. The composites were prepared by in situ silica filling in natural rubber (NR) latex using a sol-gel reaction of tetraethoxysilane. Simultaneous time-resolved wide-angle X-ray diffraction and tensile measurements revealed a relationship between the characteristic morphology and tensile stress-strain properties of the composites associating with the SIC. Results showed stepwise SIC behaviors of NR-based composites for the first time. Pure rubber phases in the biphasic structure were found to afford highly oriented amorphous segments and oriented crystallites. The generated crystallites worked as reinforcing fillers together with the in situ silica to result in high tensile stresses of the composites. The observed characteristics are useful for understanding a role of filler network in the reinforcement of rubber.

5.研究目的

Natural rubber (NR) has been widely recognized as a useful soft mater, which is both highly elastic and crystallizable under high strains. The extensive applications of NR are based on its high elasticity and excellent mechanical strength. The latter is ultimately attributable to its ability of crystallization upon stretching. Therefore, it is necessary to evaluate the strain-induced crystallization (SIC) behavior for development of high performance NR materials.

Recently, we prepared novel biphasic structured in situ silica filled NR composites by a sol-gel reaction of tetraethoxysilane using n-butylamine in NR latex. In the composites, the in situ silica was locally dispersed around rubber particles to result in the specific morphology. In order to clarify the characteristics of the biphasic structured in situ silica filled NR composites, the simultaneous synchrotron wide-angle X-ray diffraction (WAXD) and tensile measurements were conducted in this study. Nowadays, in situ generated silica in a rubbery matrix moves forward into the nanotechnology. Therefore, present results will be useful for further developing of rubber-based nanocomposites.

6.研究内容及び成果の本文

別紙に 6000 字程度で作成添付してください。(図や数式がある場合は 10 個程度にしてください)

Please see the attached.

7.今後の研究の見通し

From this study, I reported that, the *in situ* silica network was found to affect on strain-induced crystallization (SIC) behavior of natural rubber (NR). Depend on deformation scale of the composite, SIC behavior of the NR was found to be significantly affected. However, it was difficult to separate the effect of SIC and cross-linking on the SIC behavior.

As reported in the present study, the *in situ* silica/natural rubber composite is supposed to be one of the most suitable models for evaluating the effect of filler network on SIC of NR matrix. Even it contains *in situ* silica only 10 parts per hundred of rubber, but the formation of filler network is obviously detected. The formation of *in situ* silica network is ascribed to the preparation technique, i.e., soft processing technique

Therefore, in near future, I aim to verify the role of *in situ* silica network on SIC behavior under cyclic deformation of natural rubber. The obtained results are believed to be the basic criteria for material design of nanocomposites.

8.本助成金による主な発表論文、著書名

1. Y. Ikeda and A. Tohsan: “Stepwise strain-induced crystallization of biphasic-structured soft composites prepared from natural rubber latex and silica generated in situ”, *Colloid and Polymer Science* (2014), **292**(3), 567-577.
2. A. Tohsan and Y. Ikeda: “Generating particulate silica fillers in situ to improve the mechanical properties of natural rubber (NR)”, in “Chemistry, Manufacture and Applications of Natural Rubber”, S. Kohjiya and Y. Ikeda, Eds, Woodhead Publishing, Oxford, ELSEVIER (2014), 168-192.

[注 1] 本報告書は、研究終了後 3 ヶ月以内に必ず提出してください。

[注 2] (お願い)印刷物の郵送と電子媒体の添付ご提供をお願いします。インターネットメールでの送付を歓迎します。〈E-Mail: enozaidan@kokoku-intech.com〉

[注 3] この報告書を当財団の事業報告書及び当財団のホームページに掲載することがありますので、予めご了承ください。

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お寄せいただいたご意見・ご要望は今後の参考にさせていただきます。

アンケートへのご協力ありがとうございました。

以上