

Mechanical Properties of Sealing Rubber under Cryogenic Environment

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Abstract: Sealing rubber working under the cryogenic environment undergoes brittle ductile transition and loss of high elasticity, leading to a decrease in sealing performance. Mechanical properties are required in the evaluation of the sealing performance of sealing rubber. In this paper, low phenyl silicone rubber and the modified low phenyl silicone rubbers with perfluoropolyether oil and polyimide powder were selected as the research objects, and the mechanical properties of the rubber compounds at ultra-low temperature were investigated. The uniaxial tensile and compression permanent deformation tests were carried out at room temperature (23 °C) and ultra-low temperature (−196 °C). Then, the parameters of the constitutive models of the materials were obtained by simulation using the hyper-elastic material fitting module of the finite element software Abaqus. The applicability of Mooney–Rivlin model, Ogden model and Yeoh model to the sealing rubber at ultra-low temperature was discussed. The results showed that, under ultra-low temperature, the low phenyl silicone rubber modified by polyimide powder maintained the superior sealing performance in comparison with the other two rubber materials. The fitting error of Yeoh model was smaller in the fitting of uniaxial tension test, while Mooney–Rivlin model and Ogden model could predict the mechanical behavior in compression permanent deformation test more accurately.

Key words: sealing; rubber; cryogenic environment; hyper-elastic constitutive model

米其林尝试用再生聚酯纤维生产轮胎

米其林集团日前宣布与法国生物化学初创企业Carbios公司合作,将聚对苯二甲酸乙二醇酯(PET)废料制成的聚酯纤维应用于轮胎,积极践行可持续发展战略。

米其林表示,公司已经成功地应用Carbios公司开发的PET废料的酶循环工艺制造出一种满足轮胎技术要求的高韧性纤维。高强度聚酯纤维由于其抗断裂性能、韧性和热稳定性,特别适合于轮胎应用。

据悉,Carbios公司开发的循环工艺使用了一种酶,其能解聚塑料或聚酯衣物、瓶子和托盘等中所含的PET。与通过常规热机械工艺回收的PET不同,由Carbios酶循环工艺生产的单体可以进行再聚合,从而达到再利用所需的高性能等级。利用该创新技术可以回收各种PET废料,也使得生产与用PET新材料制造的产品质量水平相同的100%可循环PET产品成为可能。。

米其林聚合物研究总监Nicolas Seeboth说:

“米其林有幸成为首家利用该酶循环工艺生产再生工业纤维并且用其试制轮胎的公司。这种纤维材料是由有色的PET瓶制成的,性能与用石化原料生产的聚酯纤维相同。将这种再生纤维材料应用于轮胎为‘世界首创’,使米其林朝可持续发展的宏伟目标又迈进了一步”。

米其林的目标是2030年其轮胎中可持续原材料(来自再生资源或可循环利用)的占比达到40%,到2050年达到100%。据称,世界轮胎年销量高达16亿条,每年可消耗80万t PET。米其林的合作意味着每年将近30亿个PET瓶可被回收制成纤维并应用于米其林的轮胎中。

Carbios公司首席技术官Alain Marty称,2019年,公司利用酶循环工艺将PET废料回收制成了首批含100%精制对苯二甲酸的PET瓶。目前Carbios公司正在与米其林合作,利用PET废料获得可生产轮胎用高性能纤维的再生PET,充分证明了其工艺在向可持续循环经济模式过渡的潜力。

(朱永康)