纳米全硫化粉末橡胶对硬质聚氯乙烯的改性研究**

王庆国[1,2]，乔金梁[2*]，张晓红[2]，桂华[1,2]，赖金梅[2]，黄帆[2]，高建明[2]，宋志海[2]，谭帮会[2]

(1、北京化工大学材料学院，北京 100029；2、中石化北京化工研究院，北京 100013，*通讯联系人，E-mail: jqiao@brici.ac.cn)

研究了一种纳米级全硫化粉末丁腈橡胶（ENP-NBR）对硬质 PVC 的改性作用，旨在提高 PVC 复合材料韧性的同时，保持或增加它的耐热性。这一研究结果与传统弹性体材料改性 PVC 后的耐热性降低[1,2]现象相反。

图 1 为 PVC 复合材料的 TEM 照片。在 PVC 复合材料中，ENP-NBR 呈球状或椭圆状，粒径均匀，尺寸与辐射交联后丁腈胶乳中的橡胶颗粒相同，为 70nm 左右，且具有良好的分散性。ENP-NBR 在 PVC 基体中的这种特殊分散形态赋予了 PVC 复合材料特殊的性能，它不仅能够大幅度提高复合材料的冲击强度，还能够提高 PVC 复合材料的耐热性。经 ENP-NBR 改性后，PVC 复合材料的缺口冲击强度由纯 PVC 的 3.1 kJm^{-2}提高到 7.2kJm^{-2}，玻璃化转变温度由纯 PVC 的 77.52℃提高到 81.2℃（图 2）。

ENP-NBR粒子能够良好地分散于PVC基体中，形成宏观均相、微观分相（海岛相结构）结构。橡胶粒子充当应力集中体，诱发PVC基体中银纹和剪切屈服的产生；从而要消耗冲击能量，大幅度提高PVC复合材料的冲击强度。同时，ENP-NBR粒子又能起到终止银纹和剪切带发展的作用，使其不致发展成为破坏性的裂纹。

此外，大量的纳米级ENP-NBR粒子与PVC基体之间存在较大的界面作用，这种界面作用力限制了PVC分子链段的运动，从而提高了PVC的玻璃化转变温度。

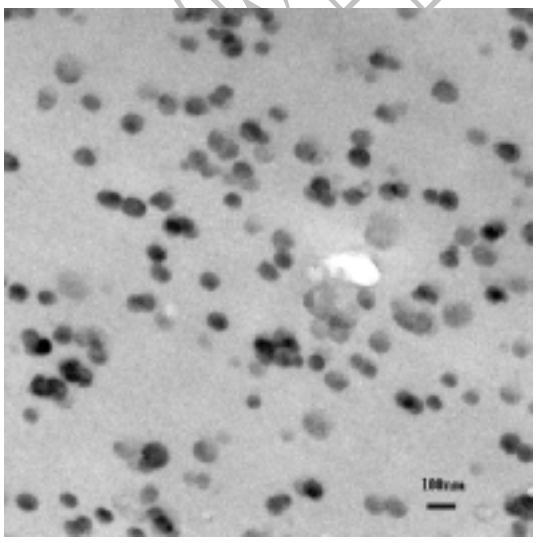

图 1 PVC/ENPs 复合材料的 TEM 照片

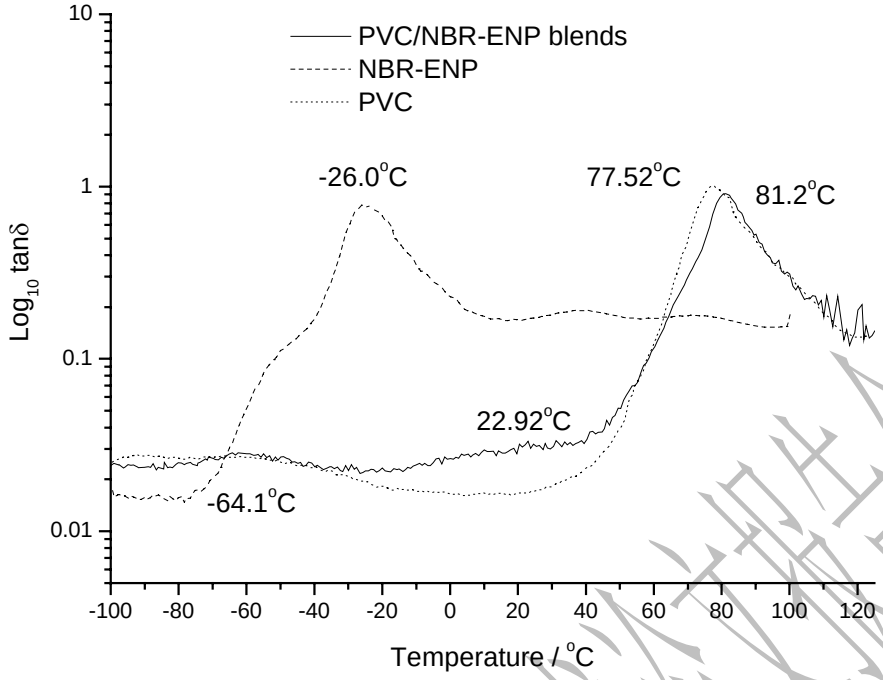

图 2 纯 PVC、NBR-ENP 和 PVC/NBR-ENP 的 lgtanδ～温度曲线

文献：

1. Charles B. Arends. Polymer toughening, Marcel Dekker, Inc. New York, Basel, Hong Kong, 1996.

2. Saeid Zerafati. Journal of Vinyl and Additive Technology 1998; 4 (1):35-38.

Rigid PVC binary nanocomposite modified with a full-vulcanized elastomeric nanoparticles of nitrile rubbers**

Qingguo Wang[1,2], Jinliang Qiao[2,*], Xiaohong Zhang[2], Hua Gui[1,2], Jinmei Lai[2], Fan Huang[2], Jianming Gao[2], Zhihai Song[2], Banghui Tan[2]

1. College of Materials Science and Engineering, Beijing University of Chemical Technology, Beijing 100029, China; 2. SINOPEC Beijing Research Institute of Chemical Industry, Beijing 100013, China; *Corresponding author, E-mail: jqiao@brici.ac.cn .

Abstract: A kind of rigid PVC binary nanocomposite modified with a full-vulcanized

elastomeric nanoparticles of nitrile rubbers (ENP-NBR) is described. The ENP-NBR was prepared by using the technique of irradiation and spray drying. Notched Izod impact strength of PVC binary nanocomposite increases from 3.1 kJ/m^2 of neat PVC to 7.2 kJ/m^2. Surprisingly, DMTA shows that the rigid PVC binary nanocomposites has higher glass transition temperature (81.2℃) than that of neat PVC (77.52℃), which is not in agreement with the traditional NBR modification. TEM indicated that ENP-NBRs were well dispersed in PVC matrix with the diameter about 70nm.

Keywords: Rigid PVC; Nano-particle rubber; Glass transition temperature

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