炭黑的接枝对填料-橡胶相互作用及动态力学性能的影响

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关键词：炭黑　填料-橡胶相互作用　动态力学性能

炭黑、二氧化硅等填料被广泛地应用于橡胶工业中。对于填充胶料，在填料和聚合物之间总是存在表面能的差异，尤其是炭黑填充橡胶。从热力学的观点看，橡胶是低表面能材料，而炭黑的表面能要高得多。因此，在混炼过程中，炭黑在橡胶中的分散很困难，即使对于在橡胶母体中分散很均匀的体系，填料在胶料储存和硫化过程中始终有絮凝形成填料网络的趋势。这也是形成 Payne 效应的根本原因。而炭黑的网络化会严重影响橡胶制品的动态力学性能，使其具有高滞后，缩短产品的使用寿命。

众所周知，在动态应力的作用下，硫化胶的模量随应变的增加而下降，这就是所谓的 Payne 效应[1,2]，这种模量的下降通常被认为是炭黑网络的破坏所致。本文拟通过在炭黑表面接枝大分子来降低其表面能，从而抑制炭黑的网络化。接枝分子的主链与橡胶分子具有很好的相容性，而其侧链的基团可以跟酸性的炭黑表面发生反应。如图 1 所示，接枝炭黑填充的混炼胶具有较低的储能模量。这是因为接枝炭黑具有较低的表面能，与橡胶基体的相容性较好，炭黑在混炼的过程中难于形成网络。与此相反，硫化后，接枝炭黑填充的硫化胶比未接枝炭黑填充的硫化胶具有更高的储能模量(图 2)。同一填充量的接枝与未接枝炭黑，橡胶基体及炭黑的流体力学效应对模量的贡献是一样的，因此，对于接枝炭黑其填充胶模量的增加可认为是由于填料-橡胶之间相互作用增加所致。图 3 是炭黑填充的硫化胶温度扫描曲线。可以看到接枝炭黑填充的硫化胶在 60℃与 90℃时的损耗因子比未接枝的低。

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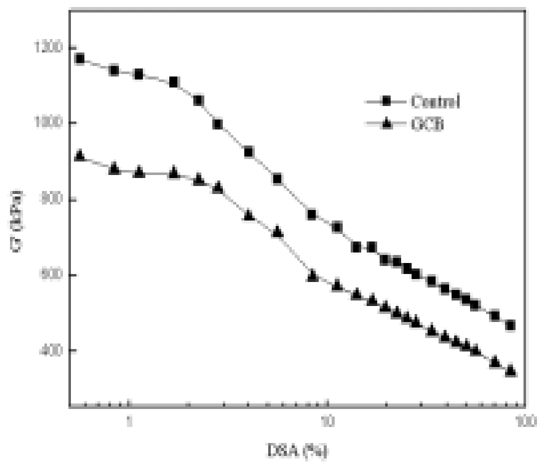

Figure 1 Strain dependence of G' at 0℃ and 100cpm for uncured SBR compound

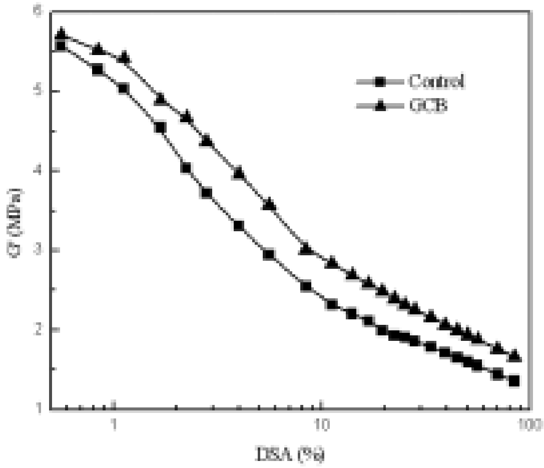

Figure 2 Strain dependence of G'at 90℃ and 100cpm for SBR vulcanizates

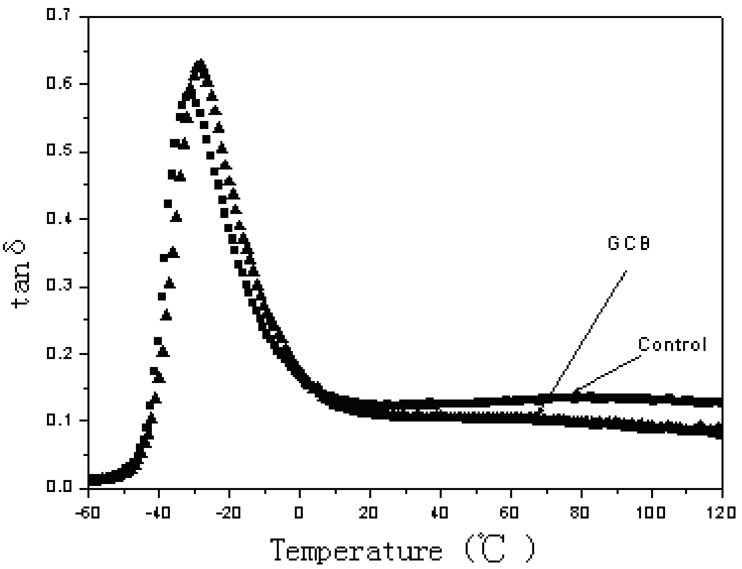

Figure 3 Temperature dependence of tan δ for carbon black filled SBR compounds

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Effect of Grafting of Carbon Black on the Filler-rubber Interaction and Dynamic Mechanical Properties of SBR Vulcanizates

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Abstract: A grafted carbon black (GCB) was prepared by adding special RFL latex into commercial carbon black (N220). The main chain of RFL has a good compatibility with the rubber matrix, whereas the side chain can react with the acidic functional groups on carbon black surface. Dynamic properties were studied over a wide range of temperatures and strains on SBR vulcanizates filled with GCB and N220. The results show that GCB can effectively enhance the filler-elastomer interaction and weaken the filler-filler interaction, which results in the decrease in the tan δ values at 60℃ and 90℃ of SBR vulcanizates compared with that of N220, which responds that GCB is beneficial to lower rolling resistance and heat generation of the vulcanizates comparison with that of commercial carbon black. Also, SBR vulcanizates filled with GCB show improved mechanical properties due to the better dispersion of filler.

Keywords: Carbon black; Filler-rubber interaction; Dynamic mechanical properties