

**TITLE** ANISOTROPIC STUDIES OF MULTI-WALL CARBON NANOTUBE (MWCNT)-  
FILLED NATURAL RUBBER (NR) AND NITRILE RUBBER (NBR) BLENDS

**AUTHOR** PATTANA KUESENG

**DEGREE** DOCTOR OF PHILOSOPHY PROGRAM IN POLYMER SCIENCE AND  
TECHNOLOGY (INTERNATIONAL PROGRAM)

**FACULTY** FACULTY OF SCIENCE

**ABSTRACT** 50/50 NR/NBR blends with various MWCNT loadings were prepared by mixing with MWCNT/NR masterbatches on a two-roll mill and sheeted off at the smallest nip gap. Then, the effect of milling direction, machine direction (MD) and transverse direction (TD), on the mechanical and electrical properties of the blends was elucidated. Dichroic ratio and SEM results confirmed that most of the MWCNTs were aligned along MD when MWCNT was less than 4 phr, and the number of agglomerates increased when MWCNT was more than 4 phr. Additionally, anisotropic properties were clearly observed when 4 phr MWCNT was loaded. At 4 phr MWCNT, 100% modulus and tensile strength in the MD were about 1.5 and 1.3 times higher than those in the TD, respectively. Moreover, electrical conductivity in the MD was superior to that in the TD by about 3 orders of magnitude. Results from dynamic mechanical tests also showed that the maximum  $\tan\delta$  in the MD sample was lower than that in the corresponding TD sample. In addition, the storage modulus at 30 °C for the MD sample containing 4 phr MWCNT was 1.15 higher than that of the corresponding TD sample. This stronger reinforcement efficiency resulted from the combination of the greater alignment and dispersion of most MWCNTs in the MD sample.