UNIVERSITY TRANSPORTATION CENTER FOR RAILWAY SAFETY

Exhibit F - UTCRS

UTC Project Information	
Project Title	Effects of Vapor Grown Carbon Nanofibers on Electrical and Mechanical Properties of a Thermoplastic Elastomer
University	The University of Texas Rio Grande Valley (UTRGV)
Principal Investigator	Robert Jones, Ph.D., Mechanical Engineering (PI) Constantine Tarawneh, Ph.D., Mechanical Engineering (Co-PI)
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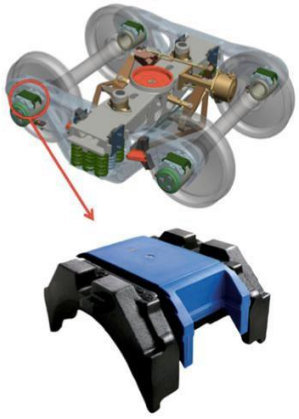
Funding Source(s) and Amounts Provided (by each agency or organization)	Federal Funds (USDOT UTC Program): $52,068 Cost Share Funds (UTPA): $14,628
Total Project Cost	$66,696
Agency ID or Contract Number	DTRT13-G-UTC59
Start and End Dates	November 2013 – December 2014
Brief Description of Research Project	This research developed a formulation of conductive additives for use in thermoplastic elastomers currently in use in railcar steering pads. Plain elastomers are insulators and prevent transmission of current from rail to frame to signal door or gate opening devices. In addition, the thermal insulating properties of these materials slow heat flow from bearings through the bearing adapter into the side-frame where it can be dissipated. Traditional conductive additives such as carbon black must be applied at high volume fraction and result in substantial increases in pad stiffness and degradation of pad durability. Carbon nano-fibers are extremely efficient conductive additives and can produce the desired conductivity at much lower concentrations and with less impact on mechanical performance.
Describe Implementation of Research Outcomes	Project achieved its goal of developing a combination of TPU and conductive polymer which met application requirements. The final

(or why not implemented) Place Any Photos Here	formulation involved the use of a lower stiffness TPU than that traditionally used in the application to allow for the stiffening effect of the conductive additive. The minimum additive level which produced the necessary conductivity was determined and lab scale batches produced. The trial material was subjected to extensive small scale material testing including tensile testing, wear resistance, thermal stability, thermal conductivity, and impact. The formulation which was developed is currently in scale-up trials for use in a conductive pad. Development was necessarily done with laboratory scale equipment and transfer molding procedures due to limits on material quantity. Scale-up of the blending process has not been a problem and commercial quantities have been prepared. These have been successfully molded into conductive parts by transfer molding. However, commercial production requires use of plasticizing screw fed injection molding. If subjected to a high enough stress during melting, the material can lose conductivity as fibers fracture. This is the current technical barrier being addressed by the PI, working with commercial providers and members of the railroad research team at UTPA.  Figure 1 Elastomeric Steering Pad  Figure 2 Test Puck of Compounded TPU (Picture courtesy of Amsted Rail)
Impacts/Benefits of Implementation (actual, not anticipated)	The program produced a commercially viable conductive TPU formulation which can make the standard pad design conductive without changing the mechanical response of the pad/adapter system. In the process, the UTCRS also developed new capabilities for molding test quantities of material by transfer molding, acquired expertise working with nanofibers, and advanced the state of the art in understanding the effects of high fiber fractions on the behavior of elastomeric polymer systems. Production of material for field trials is underway as a first step before going into commercialization by the

	railroad industry. Furthermore, the work done in this area has resulted in a Master's Thesis entitled: 1. Basaldua, D., Effects of Vapor Grown Carbon Nanofibers on Electrical and Mechanical Properties of a Thermoplastic Elastomer," Master's Thesis, The University of Texas Rio Grande Valley, December 2014. [Link to PDF (6 MB)]
Web Links • Report • Project Website	http://www.utrgv.edu/railwaysafety/research mechanical/2014/conductive-railroad-bearing-suspension-element/index.htm