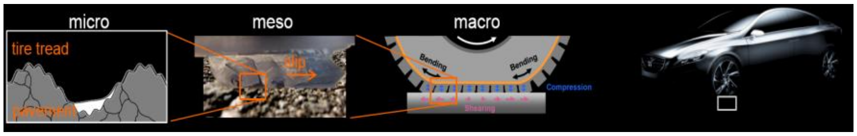
UTC Project Information

Project Title	Pavement Surface Characterization for Optimization of Trade-off between Grip and Rolling Resistance
University	Michigan State University
Principal Investigators	Roozbeh Dargazany, Ph.D. Karim Chatti, Ph.D.
PI Contact Information	Professor Department of Civil and Environmental Engineering 3546 Engineering Building, East Lansing, MI 48824 Roozbeh@msu.edu
Funding Source(s) and Amounts Provided (by each agency or organization)	$128,792 USDOT $31,003 MSU
Total Project Cost	$159,795
Agency ID or Contract Number	DTRT13-G-UTC44
Start and End Dates	October 1, 2014 to September 30, 2016
Brief Description of Research Project	Multi-scale understanding of the contact deformation behavior between pavement and tires within the contact patch is necessary in revealing the mechanism of rolling resistance, grip and sound analysis. Here, we assemble a multi-scale framework to optimize the pavement texture to reduce the rolling resistance without sacrificing grip. Since rolling resistance in high speeds appears to be dominated more by macro-scale parts of a pavement profile, and grip in low speeds is affected more by small-scale asperities, we are looking for a meso-scale surface spectrum (0.5-200 μm) that minimizes rolling resistance and maximizes grip. The main idea here is to design a surface profile to balance the trade-off between friction, adhesion and hysteresis. Viscoelastic behavior of rubber is the key here since it theoretically gives us two different material behaviors at low and high speeds, which can be used to optimize profile of surface asperities, accordingly.
Describe Implementation of Research Outcomes (or why not implemented)	Using constitutive models of rubber, we will develop a multi-scale model of rubber-surface interaction under high dynamical loads. The influence of pavement roughness, micro-texture and fractal surface geometry on the friction and hysteresis will be studied in nano- and micro- scales. This work summarizes the

existing models in macro- and mega-scales and bridge them to the developed concept in micro-scale to form a generalized framework that can predict the optimized pavement surface for a given traffic condition. In the first phase of this study, the contribution of tire type, inflation pressure, temperature, weather conditions, aerodynamic drag, and viscoelastic behavior of pavement will not be integrated into the framework.



Impacts/Benefits of Implementation (actual, not anticipated)	Rolling resistance, as one of the most significant factors in transportation industry, account for 5-7% of the total energy consumption of the nation. Therefore, there is a substantial economic and environmental interest to reduce it. Hysteretic loss accounts for 90-95% of the total energy loss of the tire, and consists of three parts: tire wall deflection, tire tread slip, and tire tread deformation. Except of the wall deflection, the other parts highly depend on the road surface. Here, by understanding and characterizing the rubber-pavement interface, our goal is to minimize the contribution of these two parts in energy loss of a tire. Field studies suggest that such improvements in pavement roughness can directly improve fuel efficiency by approximately 2-6%. Successful proof-of-concept for the proposed roughness spectrum could transform the Pavement friction design and ultimately improve the sustainability of pavements which directly leads to environmental and economic benefits. Moreover, the proposed work can strongly assist highway engineers in (i) analyzing the trade-off between pavement grip and rolling resistance, (ii) instituting pavement design processes for different traffic conditions and (iii) ranking and rating of current road surfaces for further optimization.
Web Links • Reports • Project website	<www.chpp.egr.msu.edu>