National Center for Sustainable Transportation

Project Information Form

Project Title:	Exploration of the Evolution of Primary GDI Emissions and the Impact of Secondary Pollutants to Climate and Regional Air Quality
University:	University of California, Riverside
Principal Investigator:	Patrick Roth
PI Contact Information:	Proth002@ucr.edu
Funding Source(s) and Amounts Provided (by each agency or organization):	NCST Graduate Fellowship - $20,000
Total Project Cost:	$20,000
Agency ID or Contract Number:	DOT DTRT13-G-UTC29
Start and End Dates:	June 26, 2016 – June 26, 2017
Brief Description of Research Project:	This NCST graduate fellowship award allowed Patrick Roth to focus on and complete multiple projects that will be included in his PhD thesis. Patrick has dedicated his thesis work to understanding the secondary pollutants that form when vehicle exhaust react with atmospheric oxidants. Patrick and his colleagues investigated these reactions utilizing the exhaust from new technology gasoline direct injection (GDI) vehicles operating on a chassis dynamometer in UC Riverside's Vehicle Emissions Laboratory. While the GDI vehicles are being driven on a consistent driving cycle, they collect and classify the vehicle exhaust. Simultaneously, they inject the vehicle exhaust into UCR's Mobile Atmospheric Chamber (MACh). Tailpipe exhaust includes pollutants like Particulate Matter (PM), and various gas phase pollutants (NO_x, CO_2, CO, and Volatile Organic Compounds). The gas phase pollutants when exposed to high energy UV light emitted from the sun, will react and form heavier, lower volatility products that will begin transitioning onto existing PM. This increase in atmospheric aerosol mass (secondary aerosol) is what the team are most interested in when studying these vehicles. They were able to simulate these reactions in the lab by collecting the exhaust into MACh, and turning on UV lamps. The lamps allow them to control the intensity and duration of the UV irradiation which allows them to get repeatability between tests.

	With this NCST award, Patrick investigated how the addition of a gasoline particulate filter (GPF) would affect the secondary pollutants. This study included two new GDI vehicles. Each vehicle was tested over a cold start LA-92 driving cycle. The emissions were collected and subsequently photochemically aged. After the stock configuration of the vehicles were studied, a catalyzed GPF was installed in line with the vehicle exhaust. The vehicles were once again tested over a cold start LA-92 driving cycle and the results were compared. It was found that there was over a 90% reduction in the PM directly from the tailpipe while also reducing the SOA by 40-50%. This finding will help modelers and regulators understand the positive impacts that can occur if catalyzed GPFs are installed on these newer technology GDI vehicles. Two other projects that Patrick was able to complete while supported by the NCST award focused on the effects of fuel on the secondary aerosol formation. One project focused ethanol content in the fuels (4 fuels, 10%-78% ethanol). The second study focused more on aromatic content in fuel, but also included varying ethanol (8 fuels 0% to 20% ethanol). Both studies utilized the same driving cycle and conditions to the GPF study. In both experiments, the secondary aerosol formation followed the strongest trend with aromatic content. When the aromatic content of the fuel increased, the SOA formation also increased. The inverse was true, for ethanol content. The work from these studies will provide regulators with information on how altering the fuel properties can affect the tailpipe and secondary emissions from vehicle exhaust.
Describe Implementation of Research Outcomes (or why not implemented): Place any photos here	
Impacts/Benefits of Implementation (actual, not anticipated):	
Web Links • Reports • Project website	https://ncst.ucdavis.edu/graduate-student-research/ Yang, Jiacheng, Patrick Roth, Thomas D. Durbin, Kent C. Johnson, David R. Cocker, III, Akua Asa-Awuku, Rasto Brezny, Michael Geller, and Georgios Karavalakis. “Gasoline Particulate Filters as an Effective Tool to Reduce Particulate and Polycyclic Aromatic Hydrocarbon Emissions from Gasoline Direct Injection (GDI) Vehicles: A Case Study with Two GDI Vehicles.” *Environmental Science & Technology,* 52 (5), 15 Feb 2018, pp. 3275-3284. https://pubs.acs.org/doi/abs/10.1021/acs.est.7b05641?af=R Yang, Jiacheng, Patrick Roth, Christopher R. Ruehl, Martin M. Shafer, Dagmara S. Antkiewicz, Thomas D. Durbin, David Cocker, Akua Asa-

	Awuku, and Georgios Karavalakis. “Physical, chemical and toxicological characteristics of particulate emissions from current technology gasoline direct injection vehicles.” *Science of the Total Environment*, vol. 650, pt. 1, 10 Feb 2019, pp. 1182-1194. https://doi.org/10.1016/j.scitotenv.2018.09.110