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Comprehensive characterization of individual tire- and road-wear particles through image and elemental analysis

JAYDEE A EDWARDS[1], BONNIE ERTEL[2,3], JOHN WEINSTEIN[4] AND RETO GIERÉ[1]

[1]University of Pennsylvania
[2]University of South Carolina
[3]CSS with National Oceanic and Atmospheric Association
[4]The Citadel

Presenting Author: jaydeee@sas.upenn.edu

Vehicles have become a main mode for transport and consequently a major contributor to environmental pollution. While governance of exhaust emissions has improved, the abundance of non-exhaust emissions persists. A significant portion of non-exhaust emissions consists of a type of microplastic known as tire- and road-wear particles (TRWPs). As tires undergo shear and friction forces while driving, accelerating, and braking, the outermost layer of the tire, known as tire treat, begins to break off as micro-sized pieces. These pieces mix with other road dust material, resulting in hetero-agglomerates consisting of tire particles encrusted with road dust. Every year around 6 Mt of TRWPs enter the environment worldwide. Since TRWPs consist of varying proportions of rubber and road dust, individual particle densities range from 1.2 g/cm^3 to potentially 2.5 g/cm^3. TRWPs disperse in the environment by road runoff and atmospheric deposition and accumulate in rivers, lakes, estuaries, oceans, and soil. These particles are composed of various additives and fillers that may have adverse health effects and can potentially leach chemicals. Due to a lack of data characterizing TRWPs and their mineral encrustation on an individual particle level, it is currently challenging to assess their fate in the environment. In this study, TRWPs collected from the streets of Charleston, South Carolina, are separated via density fractionation. By following this procedure, individual particles could be identified and characterized according to their particle density. Image and elemental analysis of TRWPs explore the lowest (<1.179 g/cm^3) and highest (>1.479 g/cm^3) density fractions. Imaging of individual TRWPs is achieved through scanning electron microscopy (SEM), whereas elemental analysis identifies elements found on the particles via energy dispersive X-ray spectroscopy (EDXS). Thus far, the data reveal that the higher-density TRWPs have greater mineral encrustation than their counterparts, and the detected minerals include feldspar, hematite, and possibly perovskite. These minerals are present in varying amounts, sizes, and proportions, depending on TRWP density category. Density separation and individual particle analysis is fundamental to understanding factors affecting the transport and fate of TRWPs.