Applying lessons learned from diesel exhaust to brake wear nanoparticle measurements and regulation

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Automobile friction brakes generate, in addition to coarse particles generated by mechanical processes, highly variable amount of nanoparticles from high temperature processes. In this work, four sets of front brake pads for a typical mid-size passenger car were subjected to selected parts of standardized brake performance tests believed to be reasonably realistic for common driving, and one set of pads also to the newly developed WLTP brake wear testing procedure. Tests were done on a brake dynamometer with an enclosed chamber and particles were measured in the duct serving at the outlet of the cooling air. A fast electric mobility particle sizer, checked to provide a reasonable response to different types of non-carbonaceous nanoparticles, was used to measure particle size distributions. The particle production was found to vary over about 5 orders of magnitude on both per-stop and per-kWh basis, with higher intensity, higher total energy dissipated, and higher temperature all correlated with a non-linear increase in emissions. While the emissions over the WLTP cycle were relatively low, the very high contribution of more aggressive, yet still realistic braking events, even though relatively infrequent, should not be overlooked. Just like with driving a non-DPF vehicle, aggressive, high-speed driving produces substantially more particles than defensive, gentle, do-not-spill-your-coffee driving.