Towards the reduction of brake and tire emissions: The Zero Emission Drive Unit (ZEDU-1)

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Technological advances, standardized testing, and legislation regarding engine-related emissions have been effective in reducing particulate emissions from newly registered vehicles. In order to achieve further progress here, it is important to conduct similar efforts at vehicle components that receive less attention in the context of particulate matter reduction but are relevant for any form of propulsion. This includes tires, which play a major role in the generation of coarse particles, and brakes, which emit high levels of ultrafine particles during operation. The goal of the Zero Emission Drive Unit (ZEDU-1) research project is to design and characterize a first-generation drive axle that enables zero-emission driving with high efficiency and effectiveness while remaining suitable for everyday use. Specifically, this includes a new concept for the effective minimized release of particles in the environment via absorption of tire abrasion and the development of a brake system that is free of fine dust emission even at full braking performance. From a range of braking technology, a viscous brake was selected for the battery-electric ZEDU demonstrator vehicle, to prevent any particulate emissions to the environment. Other technologies to reduce brake emissions such as new coatings of disc brakes, and the use of an induction hybrid brake are also investigated in the scope of the project.

For the technology evaluation, particle emissions will be investigated not only based on the total mass but the entire particle size distribution. This includes online measurements of particles from the range of ultrafine up to PM10 with an EEPS, OPS, and a DMS500. For offline chemical analysis, particles are size-selectively collected with an ELPI+. Besides, the fraction of non-volatile particles is determined by using a catalytic stripper.

A multi-stage test concept is planned to ensure reliable and realistic investigation of the non-exhaust particle emissions: First, a baseline for brake and tire abrasion is determined using a conventional electric vehicle (BMW i3). For this purpose, a specific enclosure was designed that allows mobile measurements on the vehicle and direct source identification. Chassis dynamometer measurements with the WLTP cycle and the new WLTP braking cycle allow reproducible measurements, as well as an estimation of various influencing factors. Second, the developed and tested sampling setup is used to evaluate the new brake coatings. Particulate emissions are measured under identical conditions and directly compared with emissions from a conventional brake. Finally, the emissions of the ZEDU demonstrator vehicle will be determined on a chassis dynamometer under the same driving cycles and environmental conditions. Additional mobile measurements are planned during runs on a test site.

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