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Engine test bed comparison of an experimental Ti_2O_4-based particulate matter filter support with the commercially available supports

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Abstract

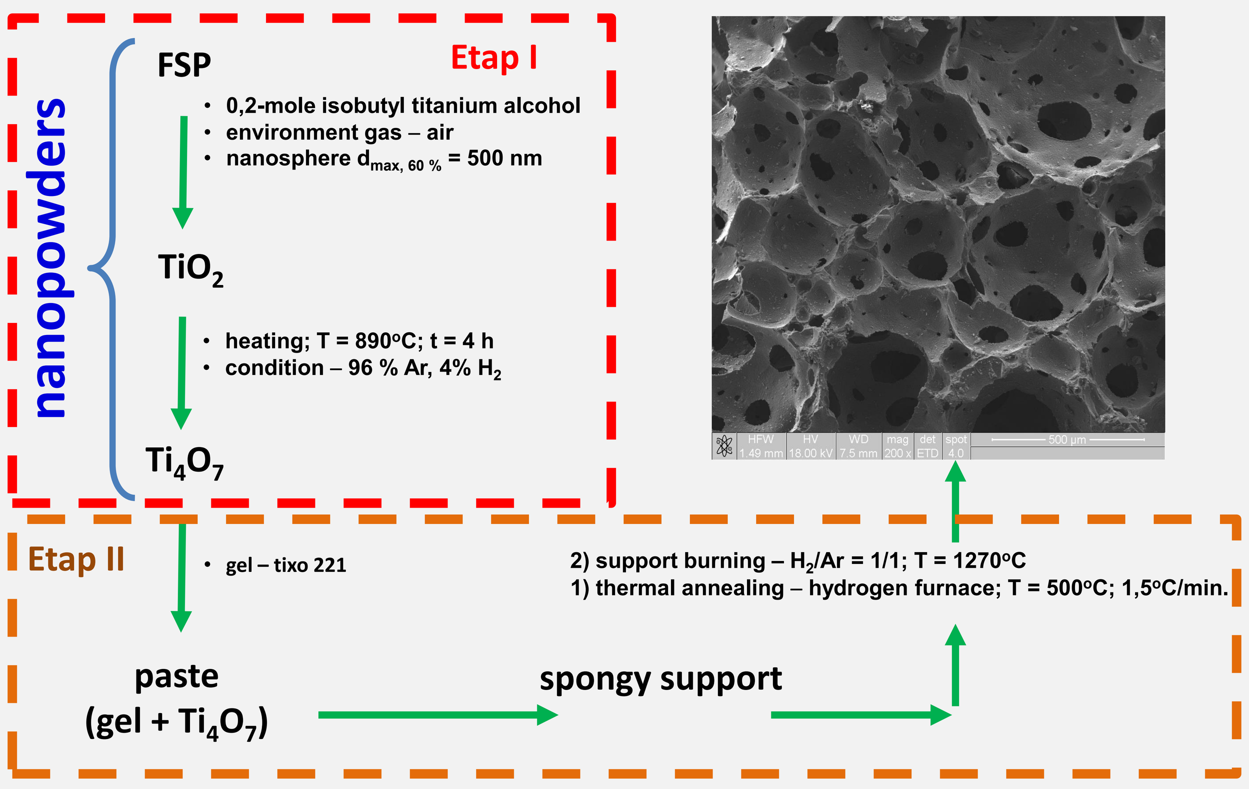
The paper presents comparative investigations of an experimental catalytic support covered with Ti_4O_7. The SiC support was assumed as a base on which a metallic layer was applied. The active layer was the catalytic combination of TiO_2-RuO_2 in the form of nanospheres made with flame spray pyrolysis. Nanopowders for the production of nano-crystallites were obtained using diffusion burners of own design that ensured flame swirls, extended heat zone and even temperature distribution in the flame structure (compared to the temperature distribution in a traditional burner). An AVL 104/8 SL test stand fitted with a diesel engine of V_{ss} = 1.3 dm³ was used for the tests. The tested catalytic systems were fitted in the exhaust system at the same distance from the exhaust manifold.

Results and Discussion

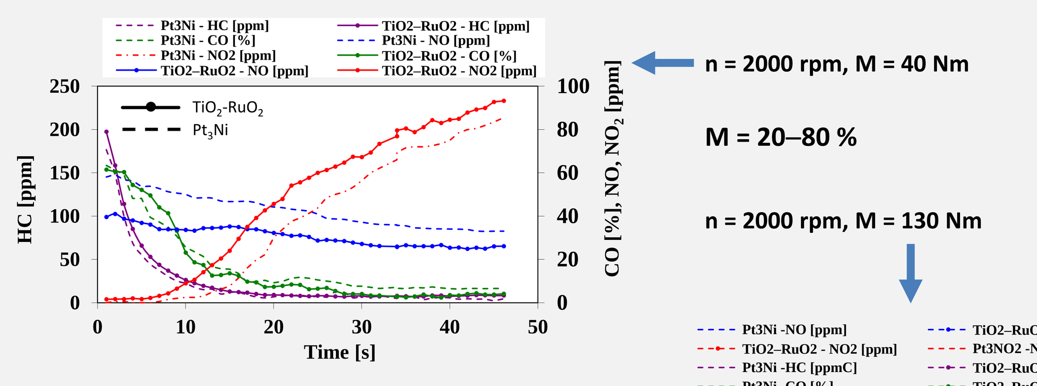
Engine measurement points at steady states, loads of 0, 40, 80 Nm and engine speed of 2000 rpm were assumed in order to validate the experimental catalytic system. The experimental catalytic system has also been tested under actual conditions of operation. A diesel engine was used for the tests. Due to the factory configuration of the engine control, including the filter regeneration procedure, two catalytic systems were selected for tests: reference and experimental. The volumes of the systems were selected according to their exhaust gas flow resistance as a parameter that determines the initiation of the active regeneration procedure. For both tested systems, a route was selected of parameters close to those of the homologation procedure. In order to preserve similar conditions of operation of the tested systems, two test runs, one after another have been carried out under the same traffic conditions. Both catalytic systems, at the time of test initiation were PM free.

In order to compare the catalytic systems, a measurement was carried out of the concentrations of HC, NO, NO_2, CO and the concentration and size distribution of PM (concentration and size distribution of PM were measured with Semtech DS and engine exhaust particulate sizer). The exhaust gas was taken from the exhaust gas flow meter on the engine test bed. The most frequently applied diesel oxidation catalyst + diesel particulate filter were treated as reference systems.

High porosity catalytic support from Ti_4O_7

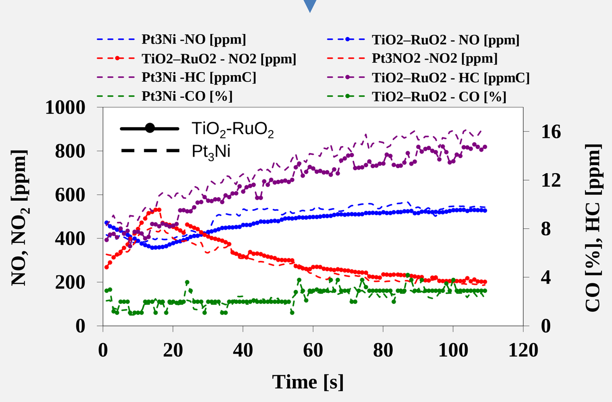


Exhaust emissions research on test bed

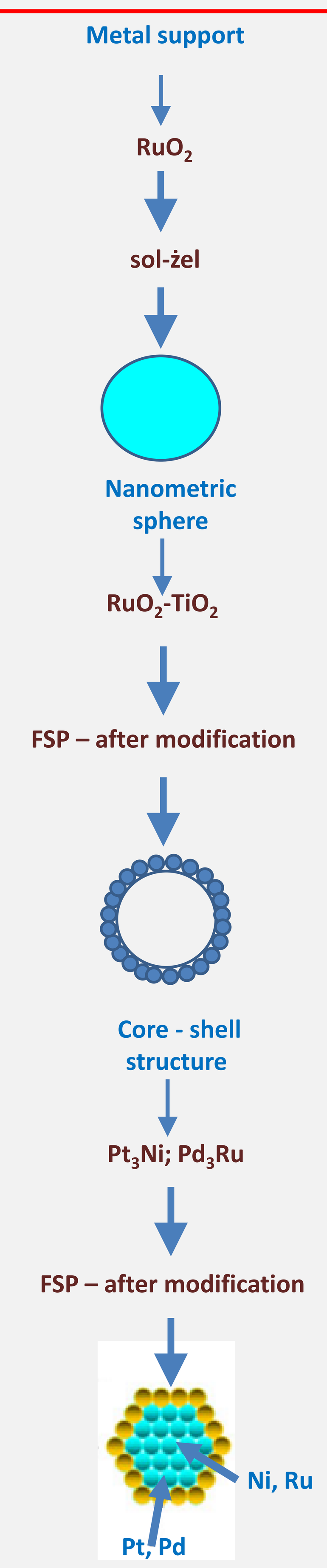


Catalytic activity

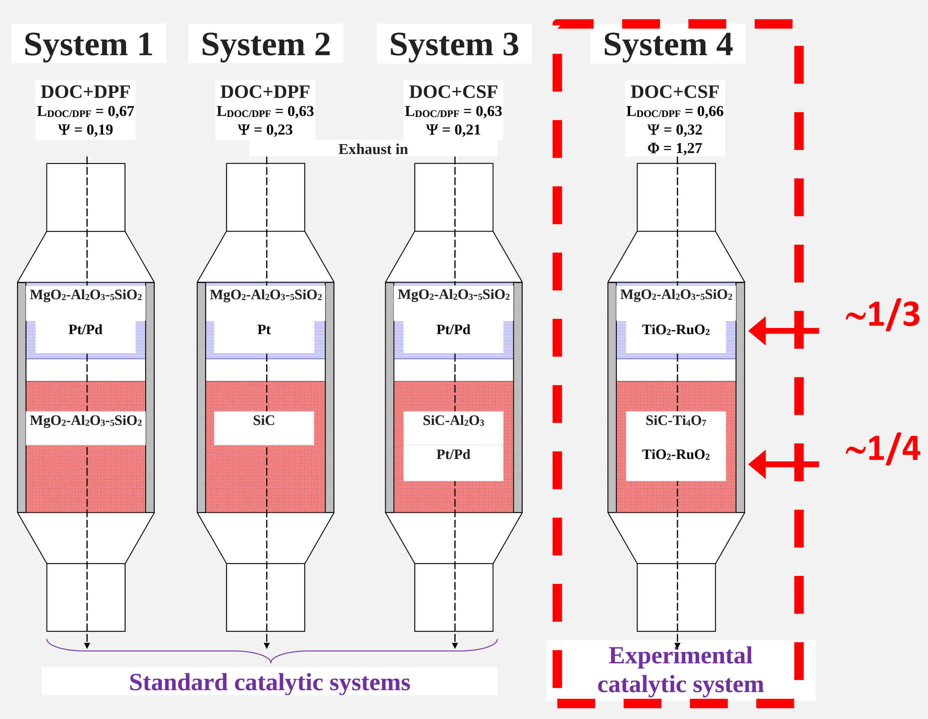
HC	CO
similar	similar
$NO \rightarrow NO_2$	
TiO_2–RuO_2 > Pt_3Ni	



Catalytic structures

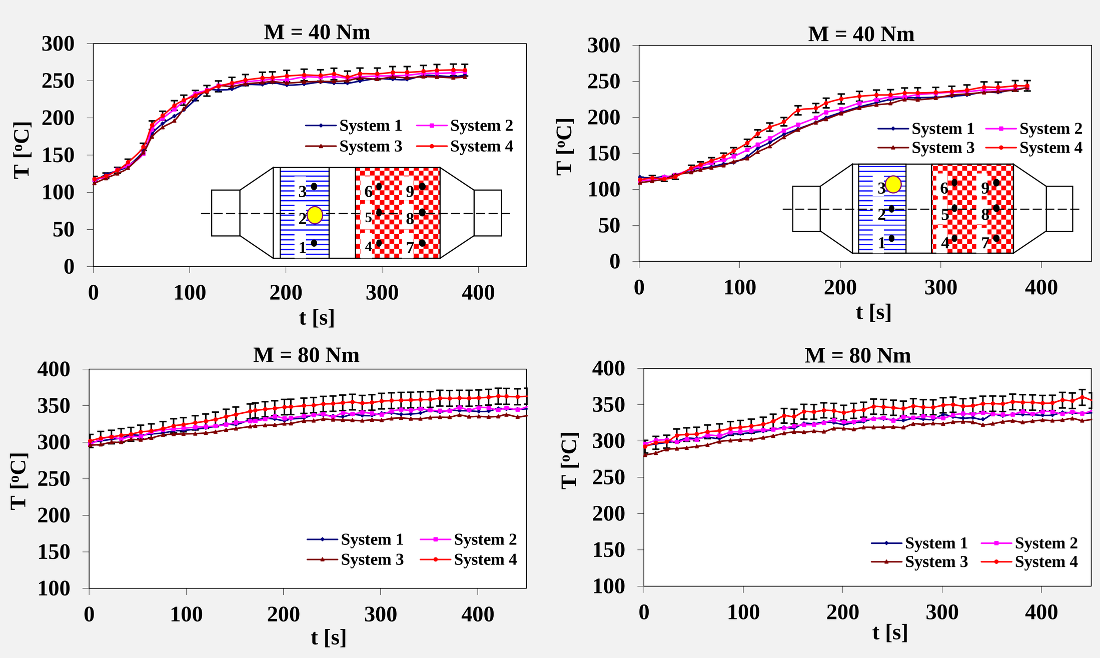


Investigated catalytic system



Test bed DOC research

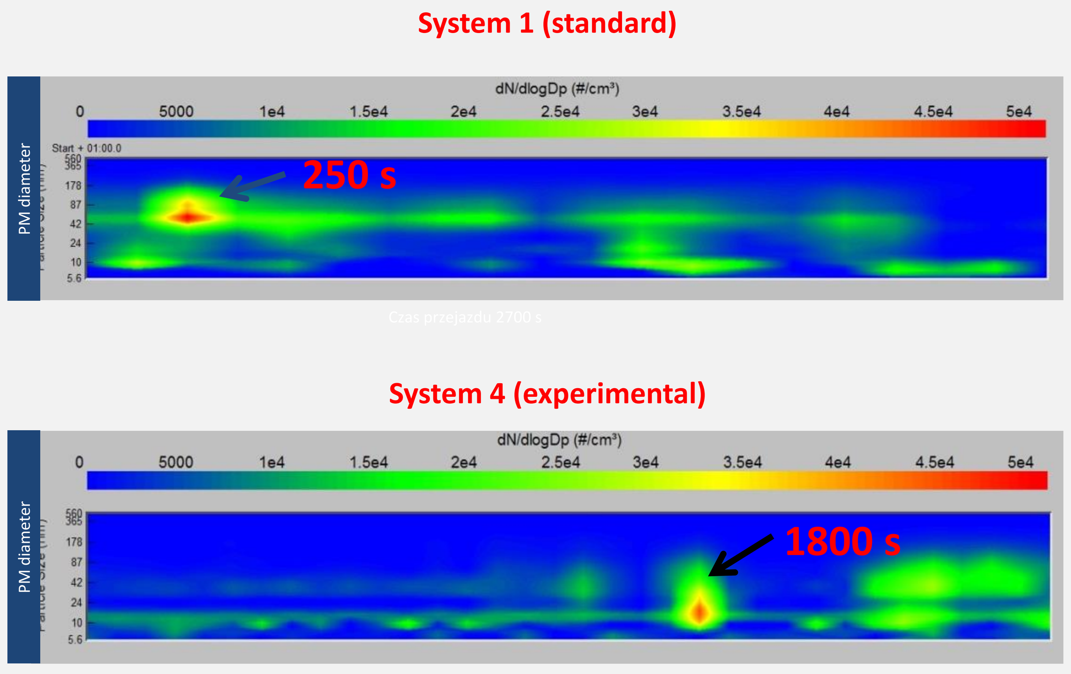
Temperature distribution; n = 2000 rpm



PM distribution

System 1 (standard)

System 4 (experimental)



Conclusion

Feathering spheres of titanium oxide (Ti_4O_7) between the carrier grains made of silicon carbide and enamelled with silicon dioxide significantly reduces the negative effects of brittle fracture, and thus improves the mechanical resistance of systems to thermal shocks present in engine exhaust gas purification systems. Techniques have been developed to ensure function in an atmosphere of pure hydrogen and ammonia, which resulted in obtaining of spongy structures during single sintering of composites such as silicon carbide-silicon oxide-titanium oxide (Ti_4O_7)-titanium nitride.

System 4 was characterized by a different dimensional distribution of PN. Concentration of PN of small diameters was observed from the very beginning of the route. Only after 16 minutes of the route the PN concentration has notably increased. The main difference between the systems 1 and 4 are particles with small diameters occurring throughout the journey, which may indicate a continuous oxidation of PM by the catalyst system Ti_4O_7-TiO_2-RuO_2. In system 1 a continuous PN concentration can also be observed for the entire route, but with larger diameters.

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