Electronic Supplementary Material (ESI) for RSC Advances.

Supplementary materials for

Promotion effect of water in the catalytic fireplace soot oxidation over silver and platinum.

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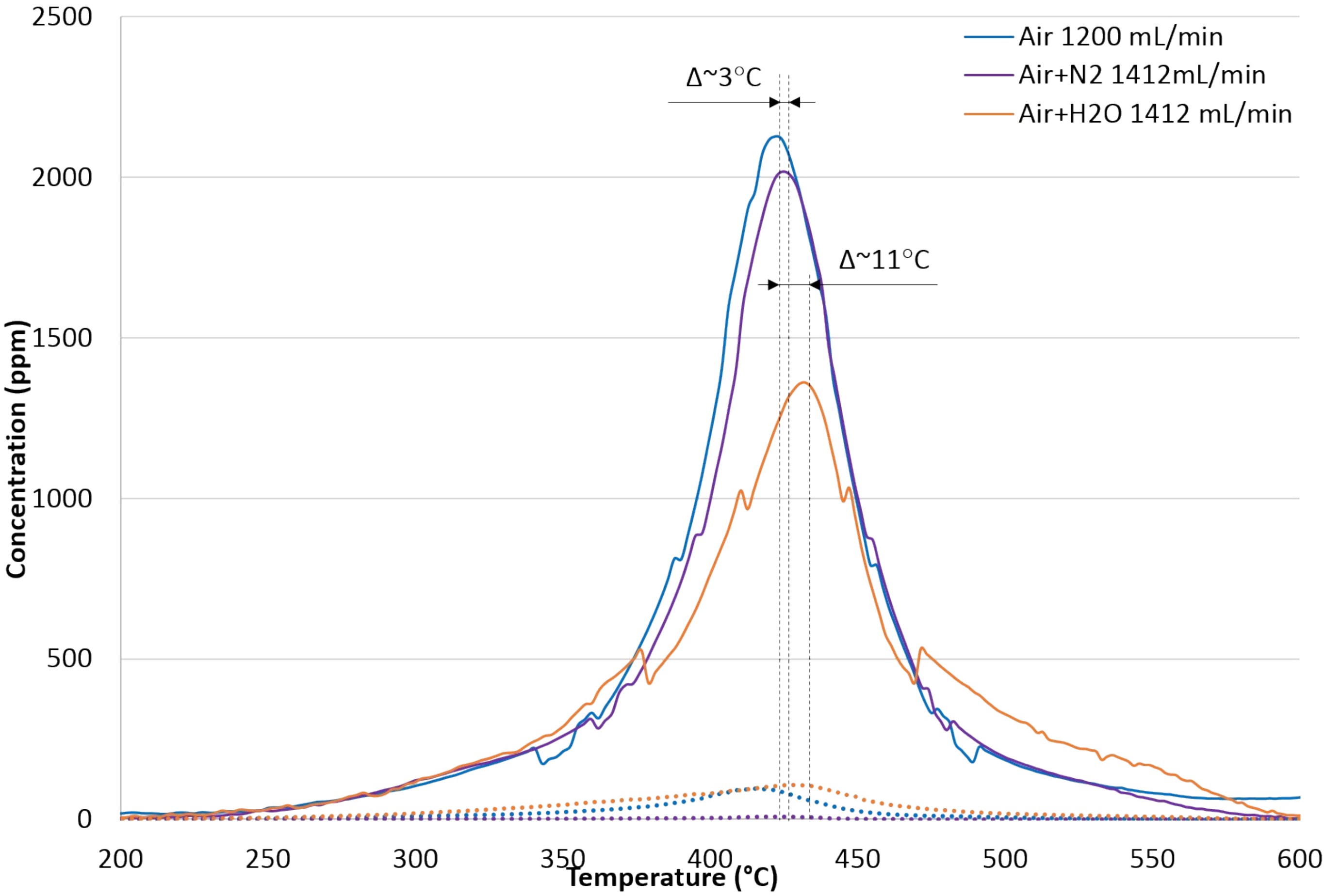
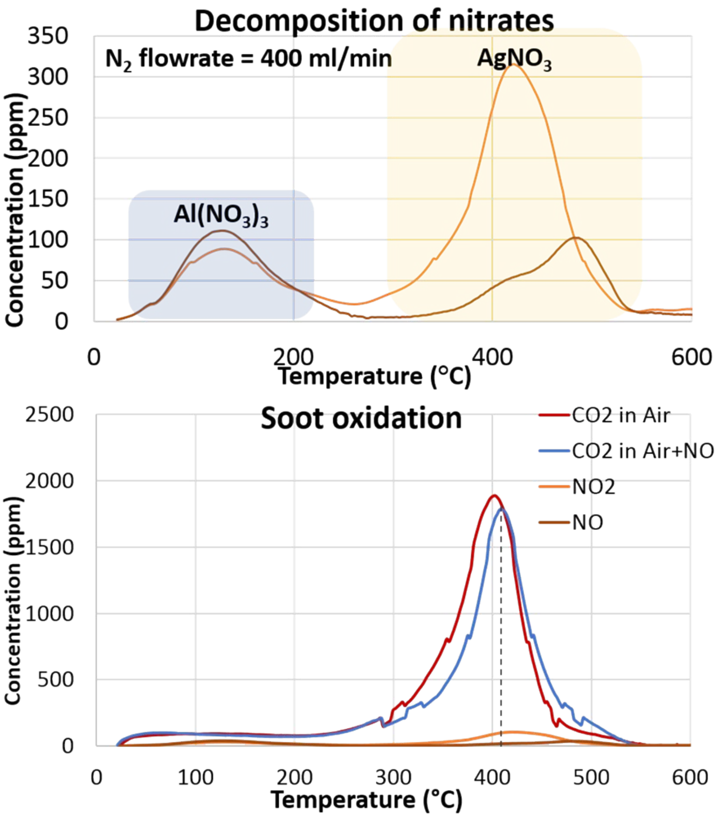


Fig. S.1 Influence of water addition and change of total flowrate on non-catalytic soot combustion. Solid line indicates CO_2 evolution, dotted line – CO evolution.



Presence of NO on gas feed poisoned silver catalysts through formation of nitrates. In order to prove this, silver catalysts were treated in 500 ppm NO in technical air with flowrate of 1200 ml min^{-1} at 300 °C for 2 hours. Then reactor with catalyst was cooled down under the same atmosphere. The catalyst was flashed with nitrogen at room temperature. Then the heat was started in nitrogen at 400 ml min^{-1}. The release of NO and NO_2 during heating indicates that silver nitrate was formed. Thus, catalyst was poisoned by NO. Comparison of soot oxidation curves and NO_x release plots shows that the more silver became available, more soot was oxidized.

Fig. S2 Poisoning of silver by NO

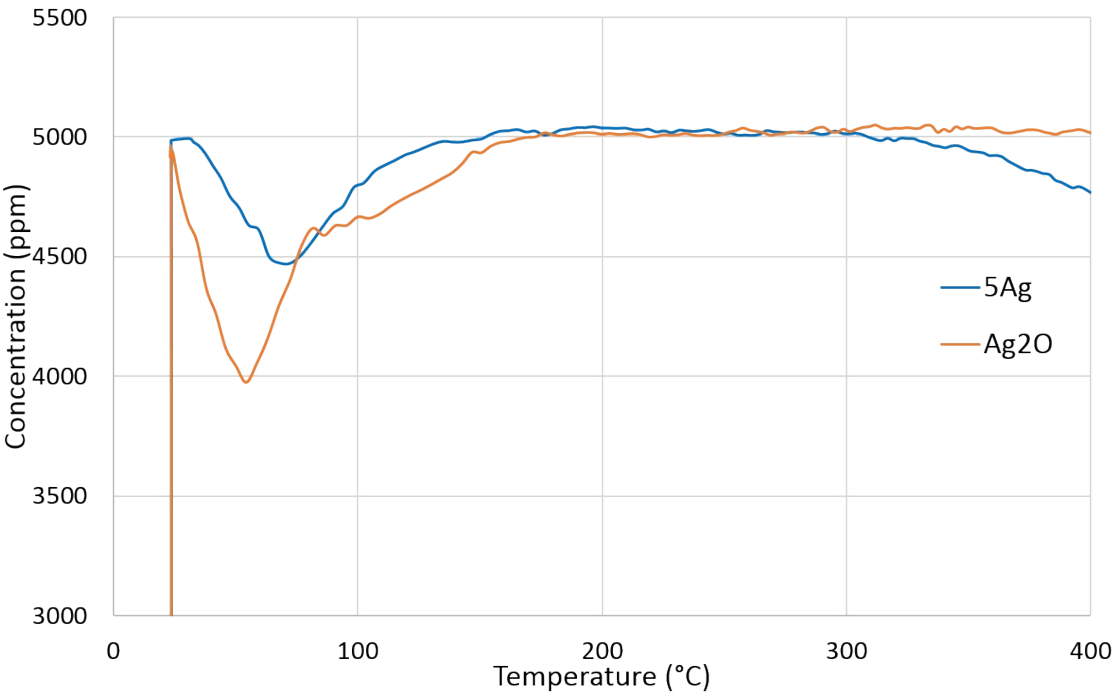


Fig. S3 CO-reduction of silver catalysts and equivalent amount of silver oxide. Amount of moles of silver for both cases are equal.

Silver oxide consumed carbon monoxide approximately two times more than silver on catalyst. Thus, supported silver exists only partially in oxide form.

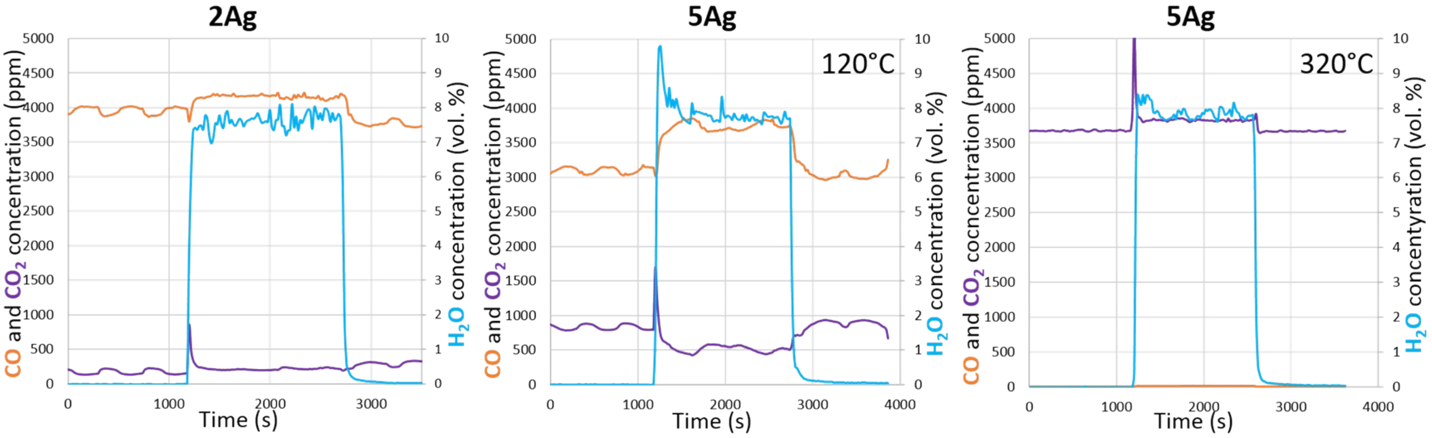


Fig. S4 Influence of water on CO oxidation over silver depending on silver loading and reaction temperature

Addition of water into gas mixture hindered oxidation of carbon monoxide. Catalysts with increased loading also showed changes in CO conversion. Thus, water interacted with silver and inhibited oxidation of carbon monoxide. Temperature had effect on conversion. However, addition of water led to partial hindering of CO oxidation. Even at high temperature water interacted with silver consuming available oxygen.

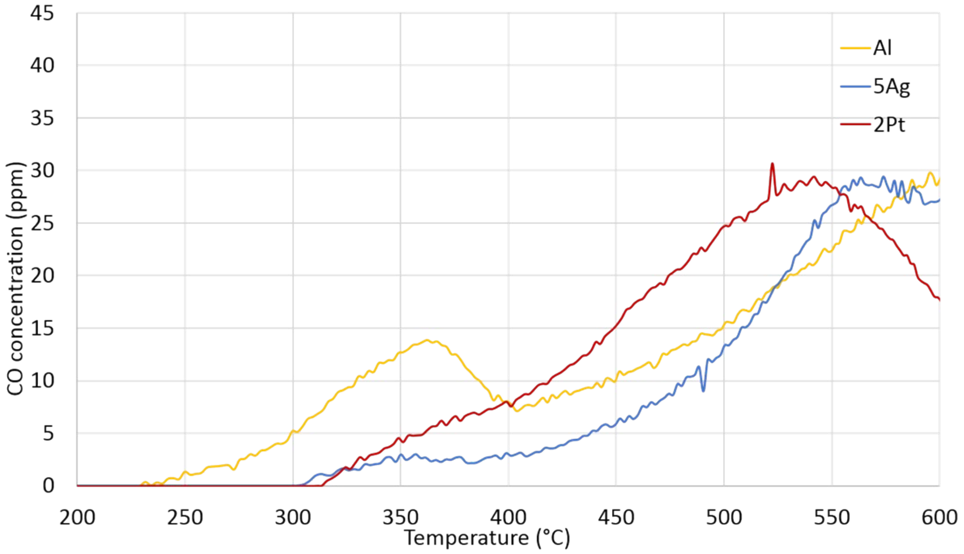


Fig. S5 Soot oxidation without oxygen. Reaction conditions: 0% O_2; 7,5% H_2O in N_2 as a balance gas.

Soot oxidation by water over silver and platinum catalysts showed almost the same results as non-catalytic soot oxidation. Thus, catalysts without oxygen cannot react with water and promote soot combustion.

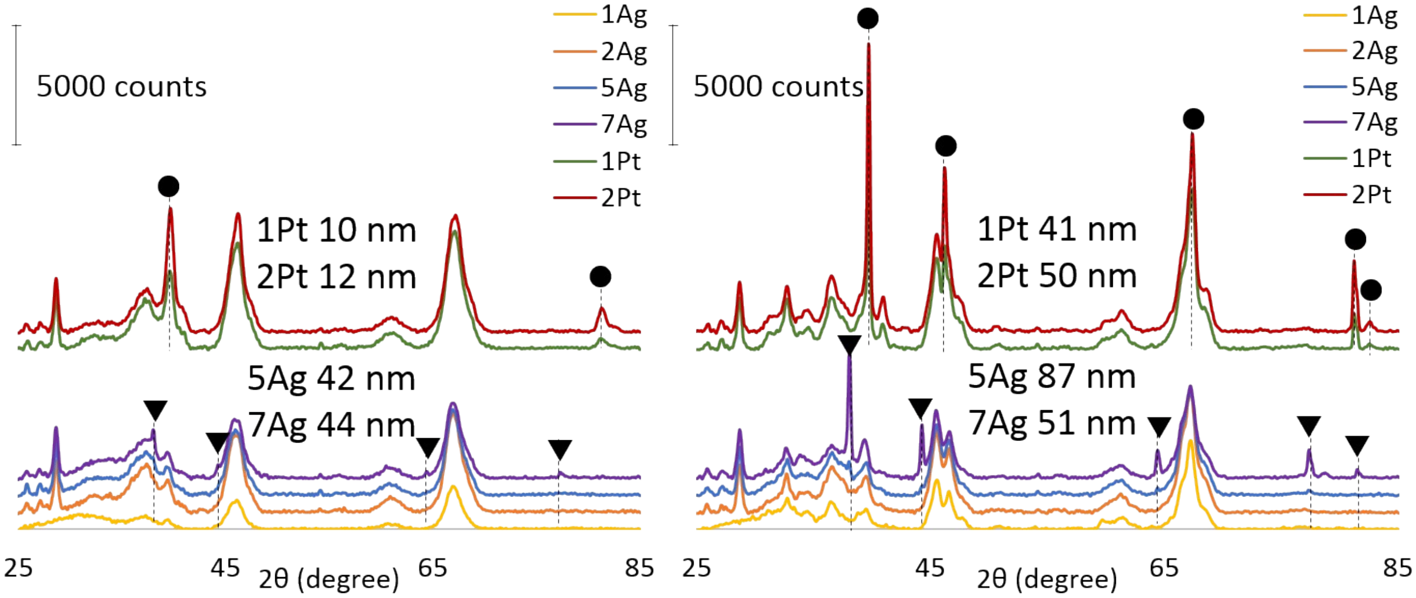


Fig. S6 Powder XRD patterns for fresh and aged Ag and Pt catalysts: metallic Pt ❦; metallic Ag ❑.

Thermal aging of catalysts caused changes in crystallinity of active components. In case of platinum catalysts, agglomeration led to loss of activity in soot combustion. However, silver catalysts retained their activity in soot combustion, although crystalline size of silver increased. For both fresh and aged silver catalysts, metallic silver was detected only for high loading.

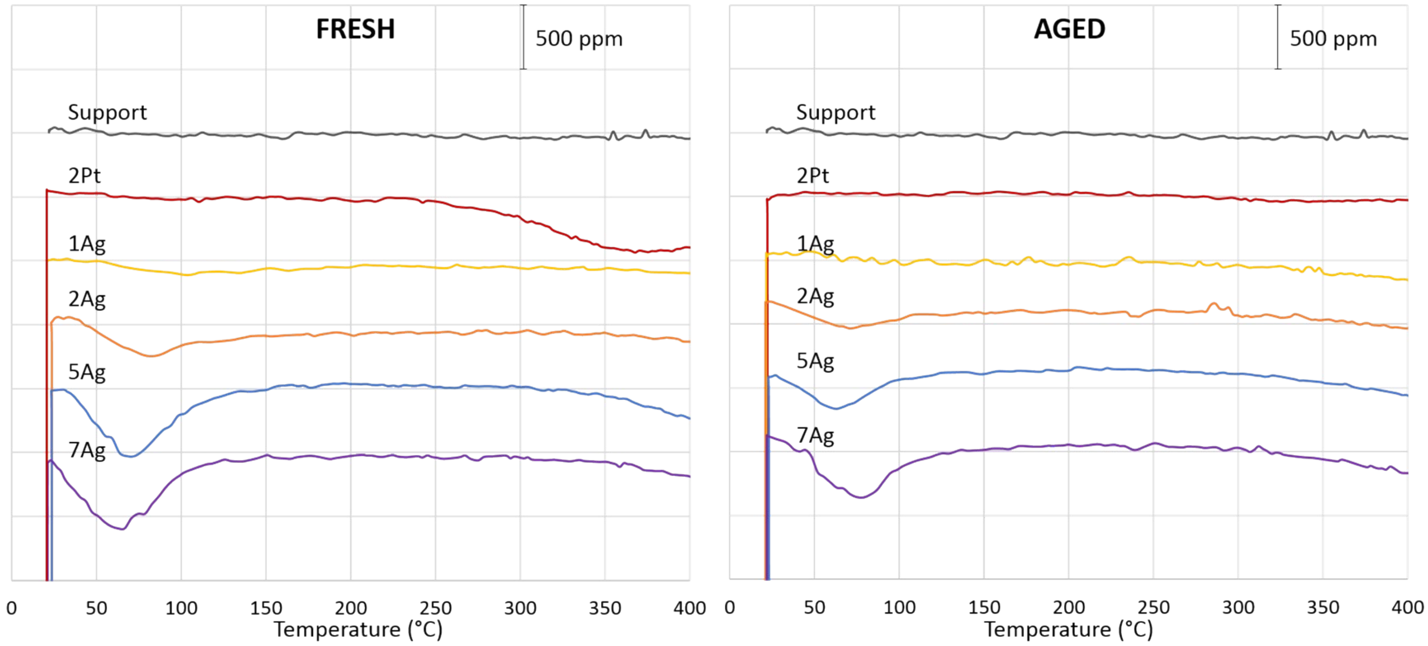


Fig. S7 Determination of chemical state of active component with CO reduction for fresh and aged catalysts.

Results show that platinum in both fresh and aged catalysts existed in metallic form. Silver consumed carbon monoxide that indicates presence of oxide on the metallic silver particles. Aged catalysts consumed smaller amount of CO compared to fresh ones. This can be explained by increased size of silver particles that led to decrease of available oxygen on the silver surface.

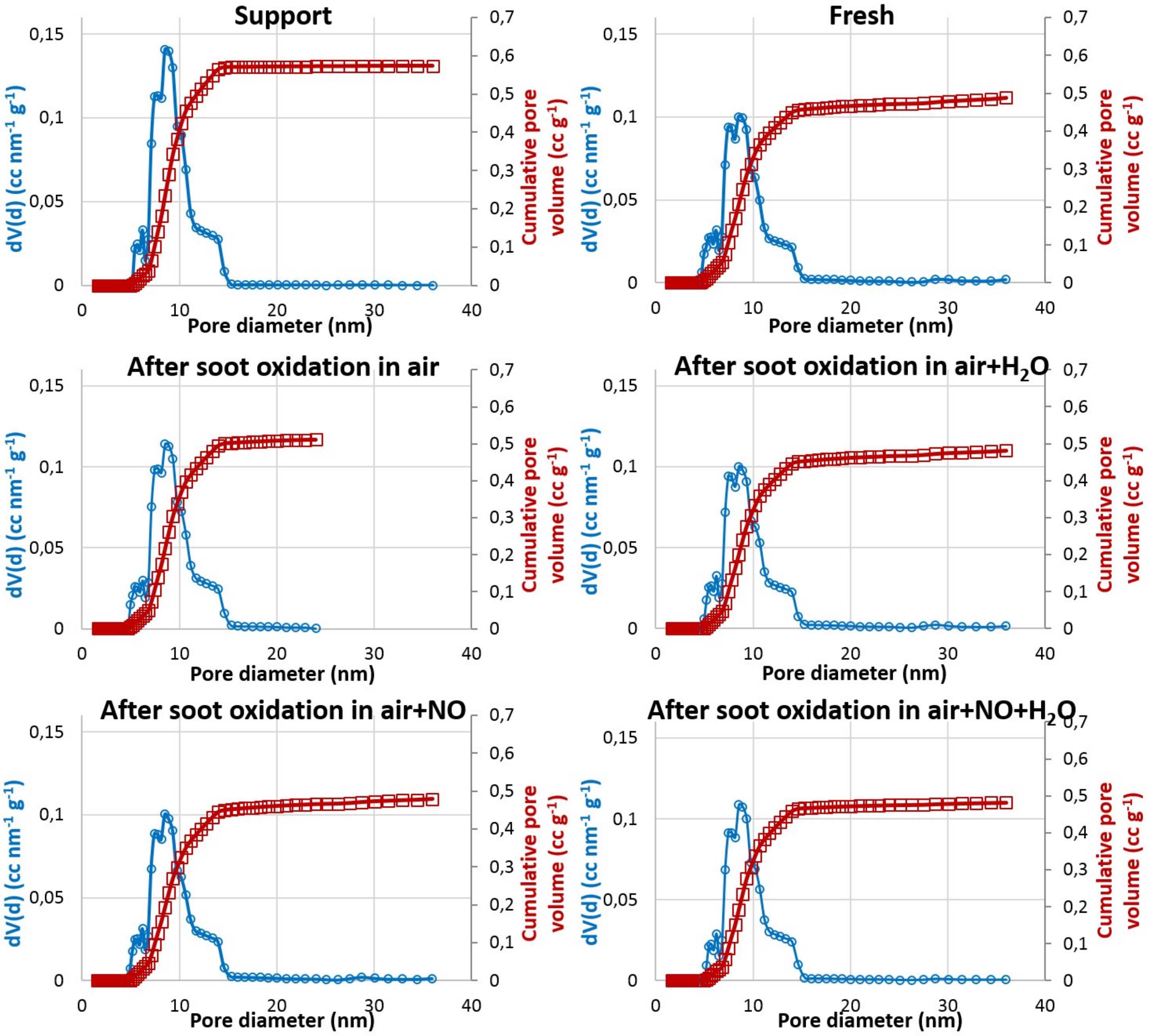
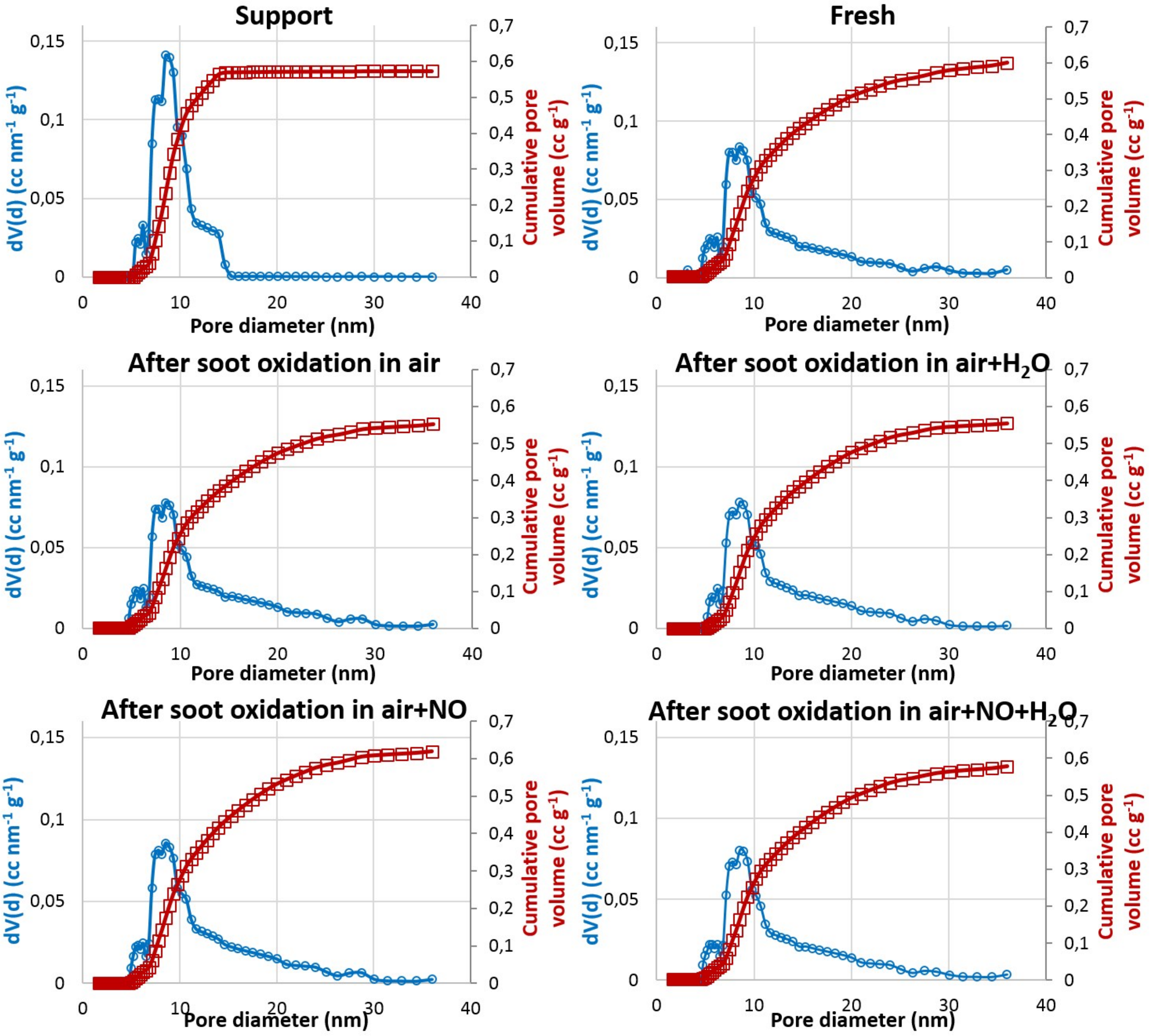


Fig. S8 Pore size distribution for support and 2Ag catalysts before and after reaction.


Support

Fresh

After soot oxidation in air

After soot oxidation in air+H_2O

After soot oxidation in air+NO

After soot oxidation in air+NO+H_2O

Fig. S9 Pore size distribution for support and 2Pt catalysts before and after reaction.

Comparison of a pore size distribution and a total pore volume of the support material and the silver-based catalysts shows that silver partially blocks the support pores. In the case of platinum-based catalysts, total pore volumes for the catalysts and support material are approximately the same. However, some changes in pore size occur after supporting of the active component. The pore size distribution and total pore volume of all catalysts after reaction do not change significantly.

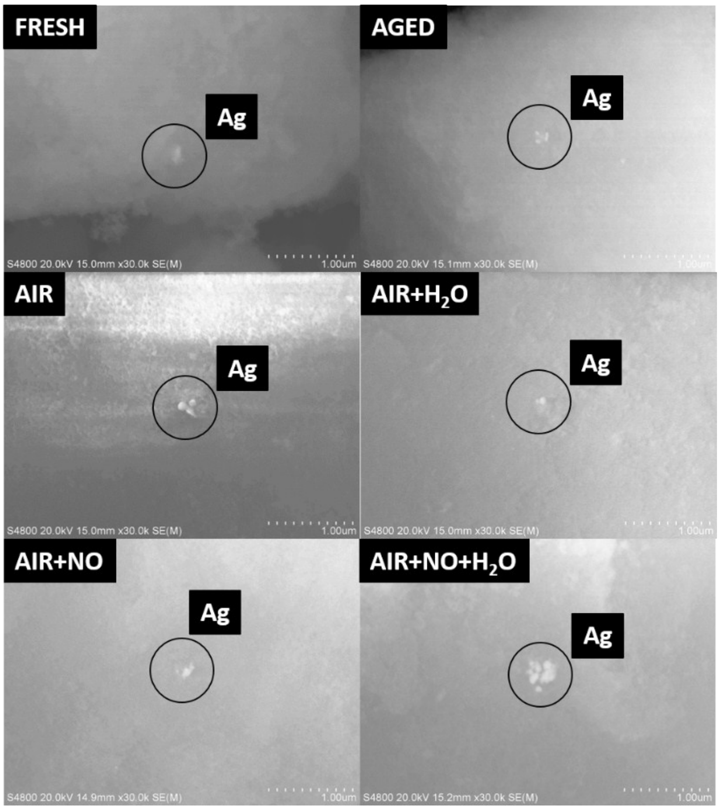


Fig. S10 SEM images of 2Ag particles on catalyst surface before and after reaction.

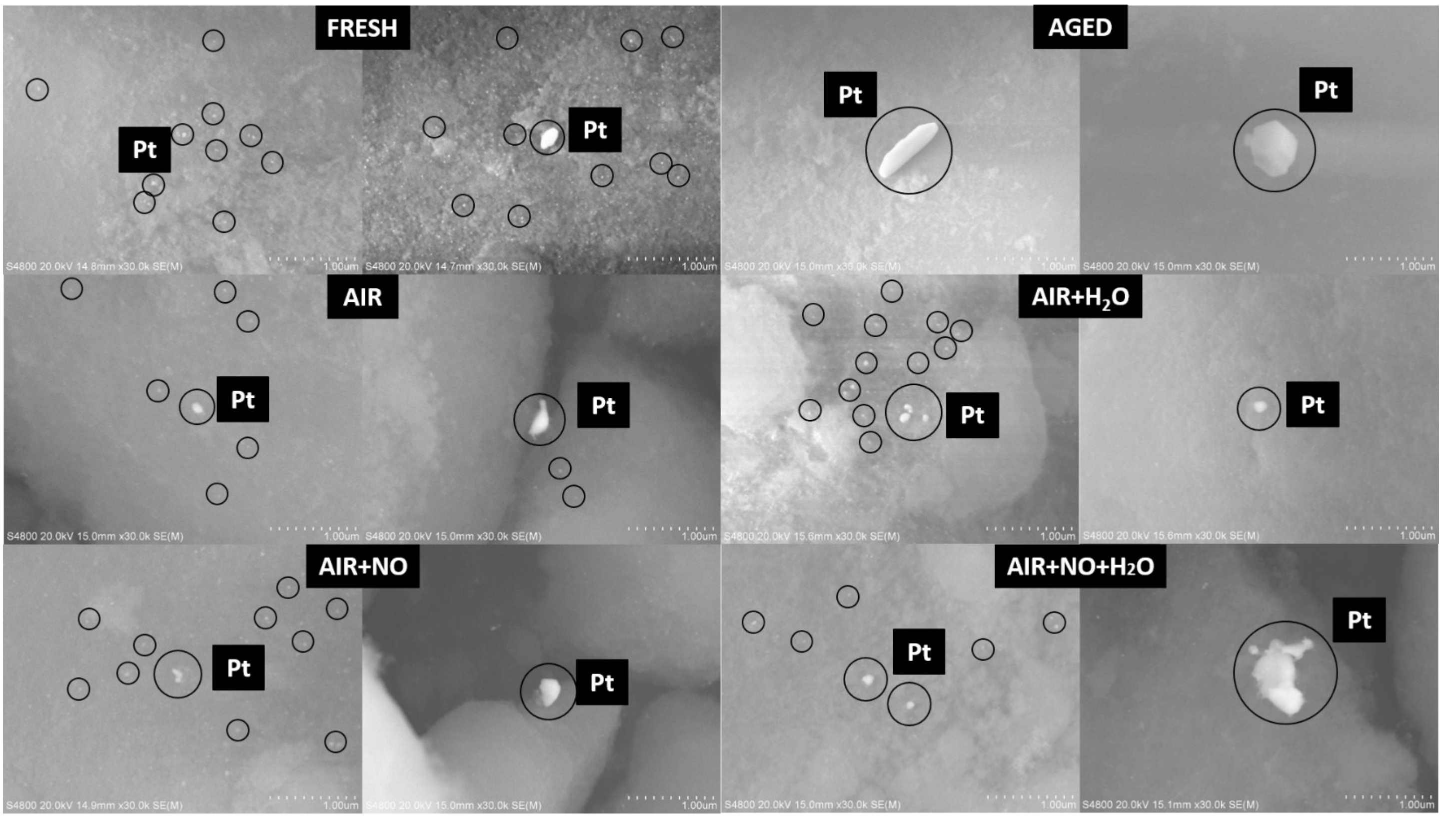


Fig. S11 SEM images of 2Pt particles on catalyst surface before and after reaction.

SEM images for the silver catalysts show that significant changes of particle size after reaction and aging do not occur. However, silver particles of spent and aged catalysts represent islands of small particles, which can be caused by redispersion of the silver particles under the influence of high temperature. In case of the platinum catalysts, SEM images of the catalysts after reaction show well dispersed small platinum particles, however, particles with larger size compared to fresh catalysts appears indicating a partial agglomeration during reaction. After the thermal ageing the platinum particles exist as large agglomerates.