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Catalytic combustion of toluene over mesoporous Cr_2O_3-supported platinum catalysts prepared by *in situ* pyrolysis of MOFs

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ABSTRACT

Three-dimensional penetrating Pt-loaded mesoporous Cr_2O_3 catalysts (Pt@M-Cr_2O_3) were synthesized by pyrolysis of MIL-101-Cr containing pre-impregnated Pt NPs. Physicochemical properties of the samples were characterized by means of various techniques including XRD, Raman, BET, SEM, TEM, XPS and H_2-TPR, and their catalytic activities were evaluated by toluene combustion compared with commercial Cr_2O_3 (C-Cr_2O_3). It is found that mesoporous Cr_2O_3 (M-Cr_2O_3) support with a high surface area of 77.40 m^2/g is composed of vast Cr_2O_3 nanocrystallites. With pre-impregnated Pt loading in MIL-101-Cr, it partly restrains the aggregation of Pt NPs during the pyrolysis of MOFs to M-Cr_2O_3 and strengthens the interaction between Pt NPs and Cr_2O_3 nanocrystallites. The obtained 0.82Pt@M-Cr_2O_3 exhibits the best catalytic performance of toluene combustion, giving 120, 140 and 144 ^oC of $T_{10\%}$, $T_{50\%}$ and $T_{90\%}$ under 1000 ppm of toluene at space velocity of 20000 mL/(g h), respectively. The investigation of the different space velocity, the catalytic stability and the effect of water vapor on catalytic activity over 0.82Pt@M-Cr_2O_3 have confirmed the good catalytic performance. Furthermore, the studies of *in situ* DRIFTS indicate toluene degradation over 0.82Pt@M-Cr_2O_3 is *via* benzoate species by rapidly transforming of benzylic and aldehydic species, and then oxidized to maleic anhydride in an aromatic-ring opening reaction, finally is decayed to CO_2 and H_2O.

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