SnO_2–CuO Gels: Novel Catalysts for the Low-temperature Oxidation of Carbon Monoxide

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Summary Coprecipitated SnO_2–CuO gels, particularly those having a Cu : Sn atomic ratio of between 0·5 : 1 and 0·6 : 1, are very active catalysts for the low-temperature ($<100°$) oxidation of CO, and after thermal activation at 450° in a 5—6% CO in air mixture the low-temperature, steady-state CO-oxidation activity of a catalyst of composition SnO_2.0·53CuO is superior, on a unit-volume catalyst bed basis, to a similarly treated commercial hopcalite (a mixed Mn–Cu oxide).

THE low-temperature oxidation of CO on thermally-stable metal and metal oxide catalysts has been studied with a view to automobile exhaust purification. Granular hydrous SnO_2 gel, after thermal activation at 200—500°, is an active CO-oxidation catalyst at temperatures below 200°.[1,2] We now report that coprecipitated SnO_2–CuO gels are very active catalysts for this reaction, and even show a room-temperature effect.

TABLE *Oxidation of* 5—6% CO *in air at flow rate of* 100 cm^3 min^{-1} *through* 3·0 cm^3 *beds of* 36—72 B.S.S. *mesh catalysts activated at* 450° *in* 5—6% CO *in air*

		Temperature required for given oxidation (°)			
		Initial	Steady state		
Catalyst	Weight (g)	50%	25%	50%	75%
SnO_2	7·4	88	160	179	186
SnO_2·0·53CuO	6·0	<0	45	65	80
Hopcalite	2·4	58	97	113	116

SnO_2–CuO catalysts were prepared by the dropwise addition of concentrated aqueous ammonia to well-stirred solutions of 0·1M [$SnCl_4$ + $Cu(NO_3)_2$] to a pH of 7·0 ± 0·1. The precipitates were washed to imminent peptization and air dried at room temperature to give granular translucent dried gel products (for Cu : Sn atomic ratios $\leqslant$ 0·7 : 1).

Catalysis studies were carried out using the previously described apparatus,[2] and the Table shows a comparison of the activity of a catalyst of composition SnO_2·0·53CuO (S^{N}_{BET} 141 m^2 g^{-1} after activation at 450°) with that of SnO_2 gel (36 m^2 g^{-1} at 450°). The values for initial activities were obtained exactly 30 min after thermal activation. The steady-state data were obtained for increasing-temperature steps after allowing the catalysts to equilibrate for *ca.* 40 h at temperatures which gave steady-state oxidations of between 5 and 20%. It is apparent that the freshly activated SnO_2–CuO catalyst is very active at temperatures below ambient and even after equilibration to steady-state conditions it still shows some room-temperature activity.

It has been confirmed that the activity of SnO_2–CuO catalysts cannot be ascribed to the presence of active CuO on an inactive SnO_2 support since, upon increasing the Cu : Sn atomic ratio of the gels (from 0 : 1 to 1 : 1), a maximum CO-oxidation activity (expressed as rate per unit weight, per unit surface area or per unit-volume catalyst bed) is observed at a Cu : Sn atomic ratio of between 0·5 : 1 and 0·6 : 1. Further confirmation of the active participation of tin in the SnO_2–CuO gels was obtained by assessing the catalytic activities for CO oxidation of similarly prepared Al_2O_3–CuO gels. These had specific surface areas (100—200 m^2 g^{-1}) comparable with those of the SnO_2–CuO gels, but were found to have negligible CO-oxidation activity for temperatures up to at least 100°.

The Table also contains data for steady-state CO oxidation on a similarly treated hopcalite (mixed Mn–Cu oxide) supplied by Hopkin and Williams. Although the hopcalites are very effective low-temperature CO-oxidation catalysts after activation at moderate temperatures (200—300°), they are known to lose much of their activity when subjected to higher temperatures.[3] After heating in CO–air at 450°, the low-temperature activity of the hopcalite is inferior (see Table), on a unit-volume catalyst bed basis, to that of the SnO_2–CuO catalyst.

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