

Supplementary Material: On the Activity and Selectivity of CoAl and CoAlCe Mixed Oxides in Formaldehyde Production from Pulp Mill Emissions

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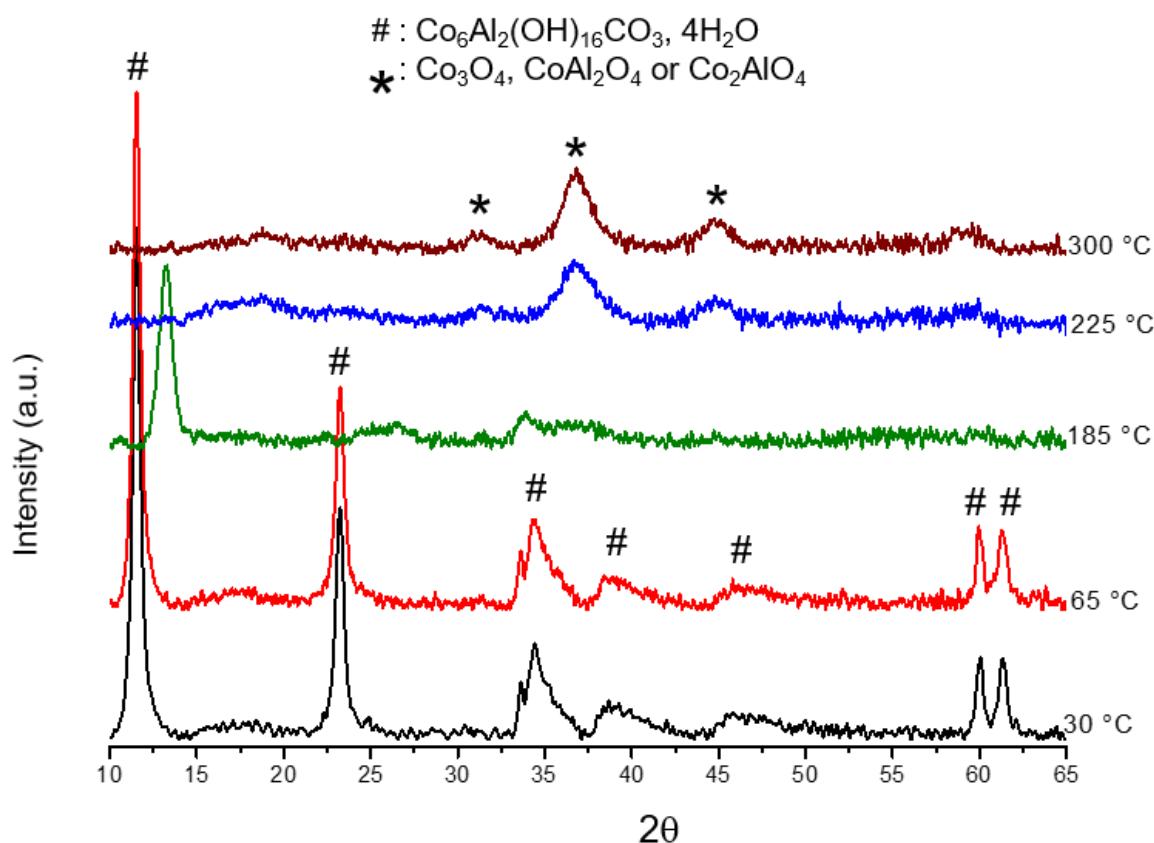


Figure 1. XRD diffractograms related to the destruction of the lamellar structure for CoAl.

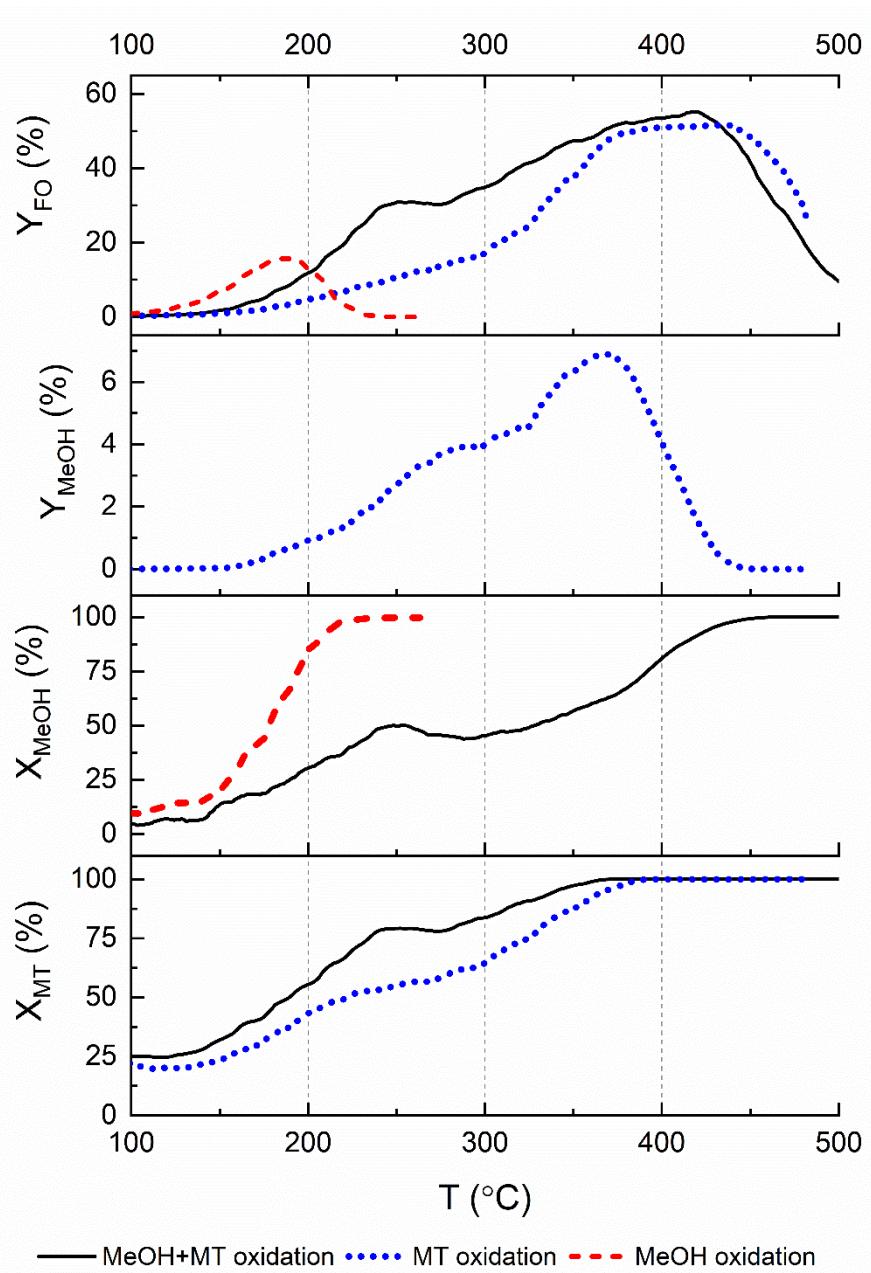


Figure S2. Reactants conversions, methanol and formaldehyde yields in the methanol (500 ppm) and methanethiol (500 ppm) mixture reaction, methanol reaction (1000 ppm), and methanethiol reaction (1000 ppm) over the CoAl catalyst.

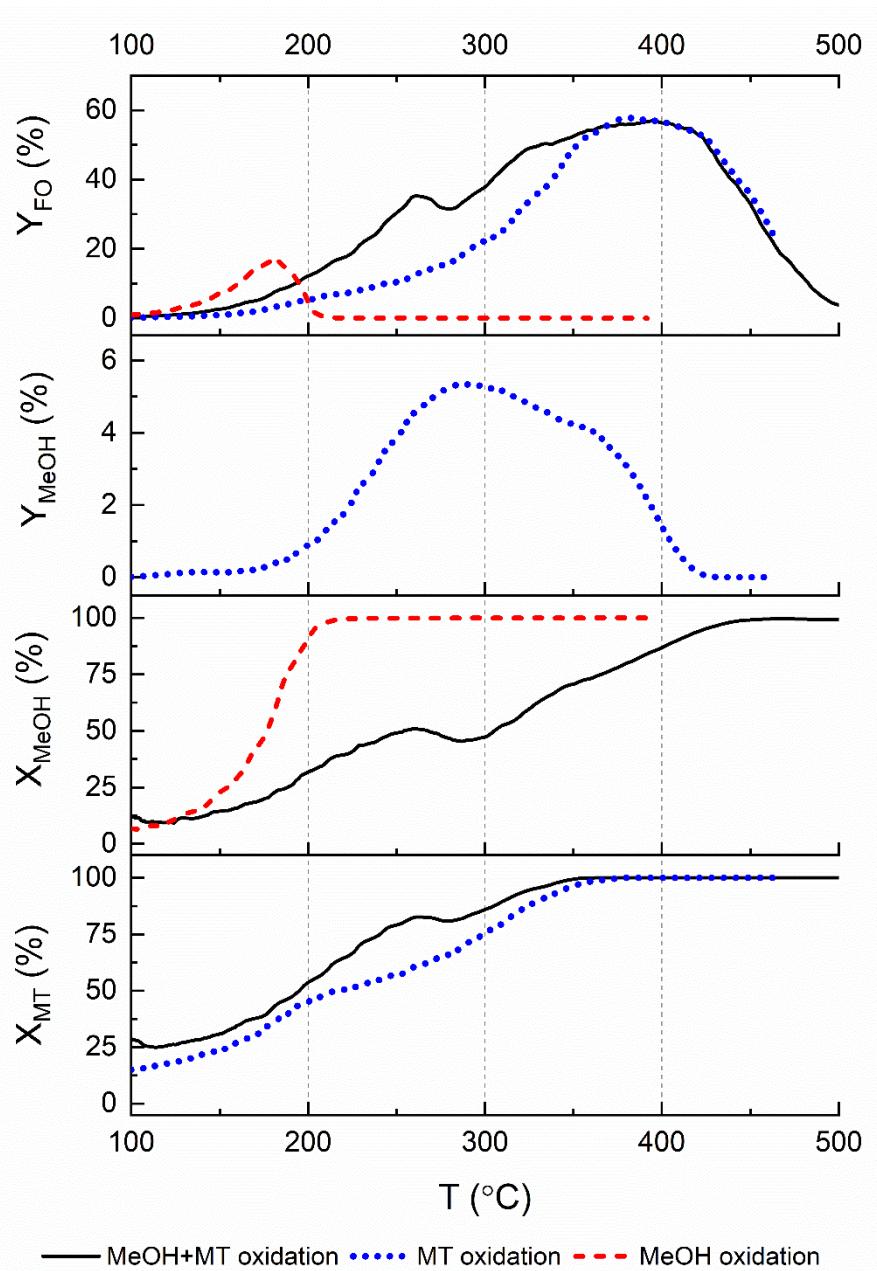


Figure S3. Reactants conversions, methanol and formaldehyde yields during methanol (500 ppm) and methanethiol (500 ppm) mixture reaction, methanol reaction (1000 ppm), and methanethiol reaction (1000 ppm) over the CoAlCe catalyst.

Table S1. Binding energies of O 1s and Ce 3d for fresh and used-16h CoAlCe pellets.

CoAlCe-P	O 1s (eV)			Ce 3d _{5/2} (eV)				Ce 3d _{3/2} (eV)			
	O _α	O _β	O _γ	Ce ³⁺	Ce ⁴⁺	Ce ⁴⁺	Ce ⁴⁺	Ce ³⁺	Ce ⁴⁺	Ce ⁴⁺	Ce ⁴⁺
Fresh inner surface	530.0	531.9	532.7	886.4	883.0	889.9	898.2	904.3	901.0	908.3	916.7
Fresh outer surface	530.0	530.9	532.7	886.3	883.0	889.9	898.2	904.0	900.9	908.3	916.7
Used-16h inner surface	530.7	532.0	532.3	886.6	883.4	889.5	-	904.8	901.4	907.9	-
Used-16h outer surface	530.7	531.9	532.4	886.7	883.4	889.4	899.3	905.4	902.3	908.6	-

O_α lattice oxygen. O_β chemisorbed oxygen. O_γ oxygen from carbonates or water

Table S2. Binding energies of Co 2p, Al 2p, Si 2p, and S 2p for fresh and used-16h CoAlCe pellets.

CoAlCe-P	Co 2p _{3/2} (eV)		Co 2p _{1/2} (eV)		Al 2p (eV)			Si 2p Si ⁴⁺	S 2p _{3/2}	S 2p _{1/2}
	Co ²⁺	Co ³⁺	Co ²⁺	Co ³⁺	Al ⁰	Al ³⁺	AlOOH or Al(OH) ₃		S ⁶⁺	S ⁶⁺
Fresh inner surface	781.9	780.2	796.7	795.1	71.0	73.5	75.0	103.2	-	-
Fresh outer surface	782.3	780.3	796.8	795.2	71.1	73.6	75.2	103.4	-	-
Used-16h inner surface	783.5	781.0	797.7	795.9	71.5	74.1	75.0	103.0	169.1	170.3
Used-16h outer surface	781.9	780.2	797.6	795.9	71.8	74.2	75.1	103.1	169.2	170.4

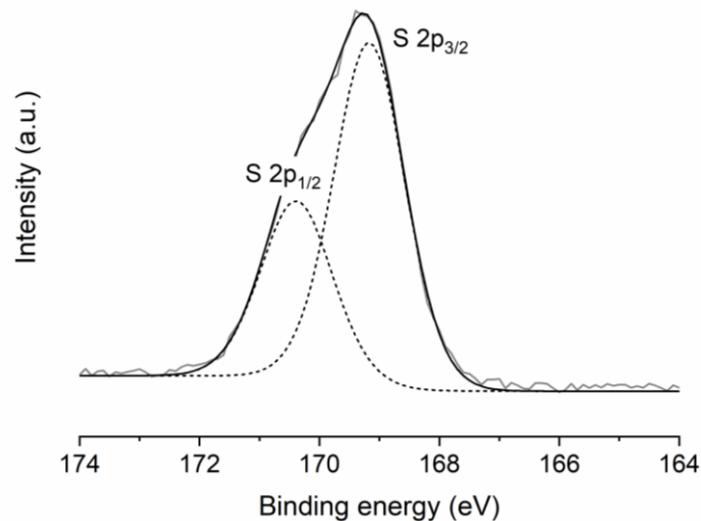


Figure S4. The XPS spectra of S 2p for the used-16h CoAlCe pellet.

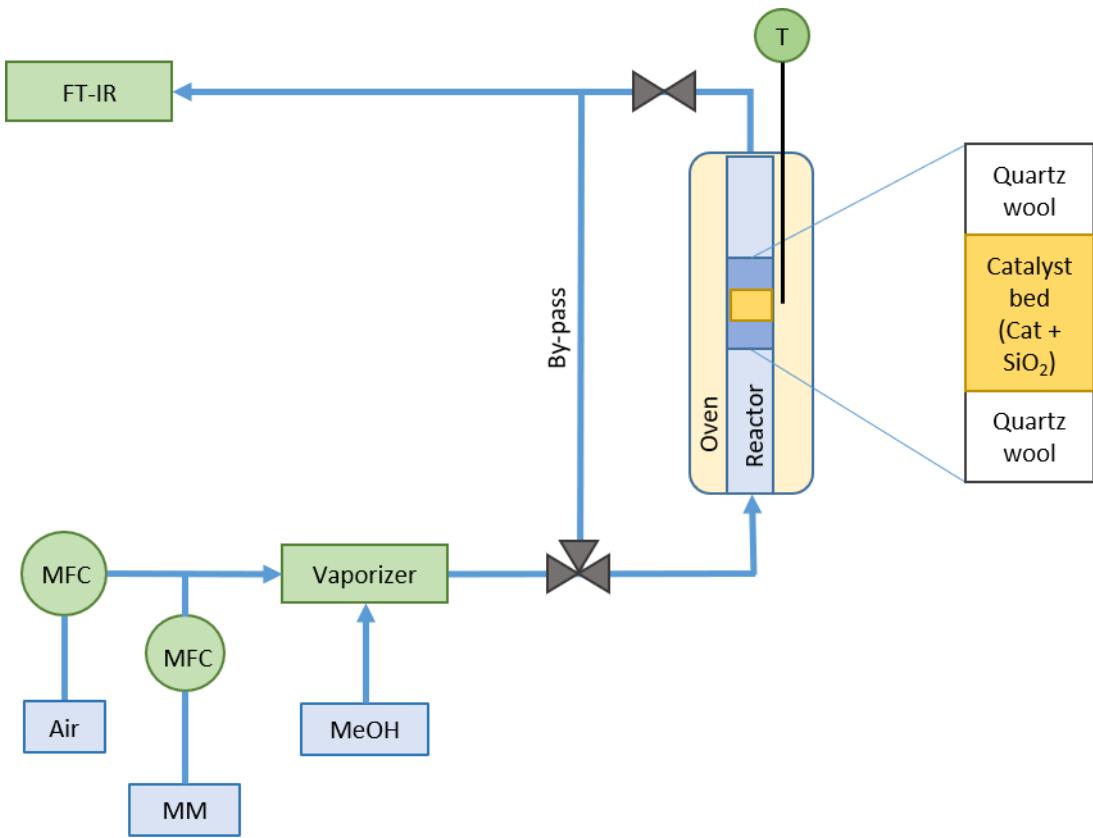


Figure S5. Laboratory-scale set-up for light-off and stability experiments.

In the oxidation of MeOH, MT, and the mixture of these compounds, the measured compounds were: water vapor (H_2O), carbon dioxide (CO_2), carbon monoxide (CO), nitrogen monoxide (NO), nitrogen dioxide (NO_2), nitrous oxide (N_2O), sulfur dioxide (SO_2), methane (CH_4), sulfur trioxide (SO_3), formaldehyde (CH_2O), methanethiol (CH_3SH), dimethyl sulfide (C_2H_6S), dimethyl disulfide ($C_2H_6S_2$), formic acid (CH_2O_2), and methanol (CH_3OH).