Supplementary Information (SI) for Catalysis Science & Technology.

Supporting information

The effects of SO_2 impurities on CO_2 electroreduction on bare silver and SiO_2 coated silver in different cell geometries

Ming Li, *[a] Shilong Fu,[b] Ruud Kortlever [b] and J.Ruud van Ommen *[a]

Table of contents

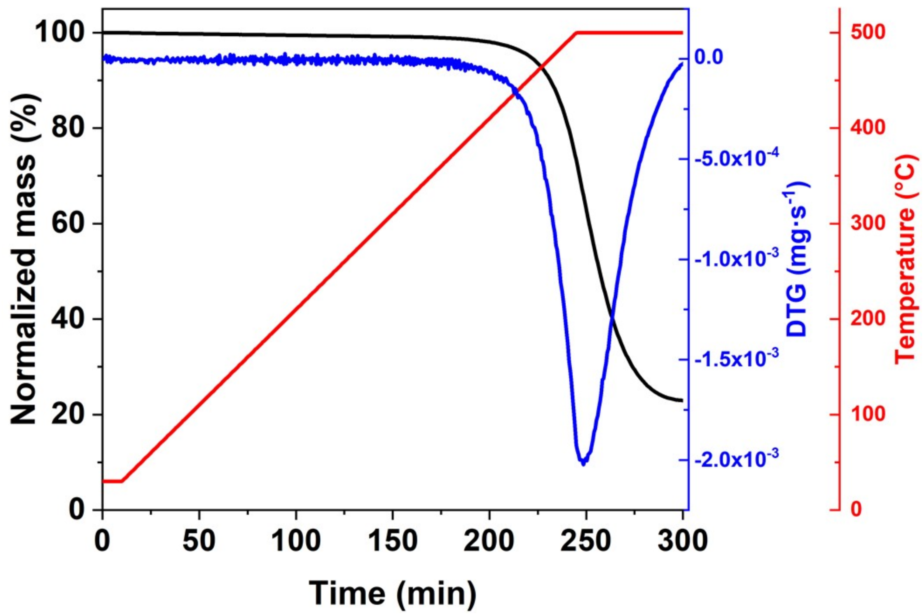

Figure S1. TG/DTA analysis of the original Ag/CB catalyst.

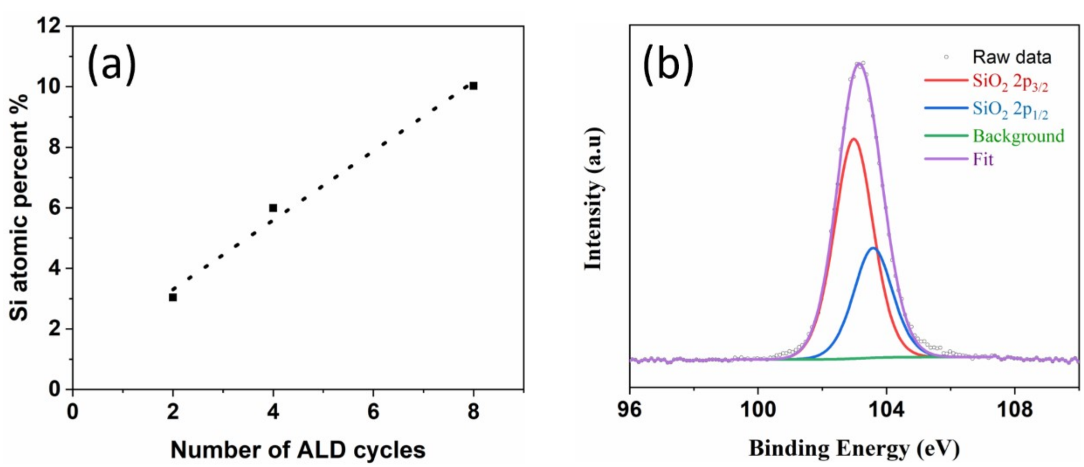

Figure S2. (a) Growth per ALD cycle of SiO_2 deposition on the surface of Ag/CB catalyst. (b) Si 2p XPS spectra of the Ag/CB catalyst with 8 cycles of SiO_2 coating.

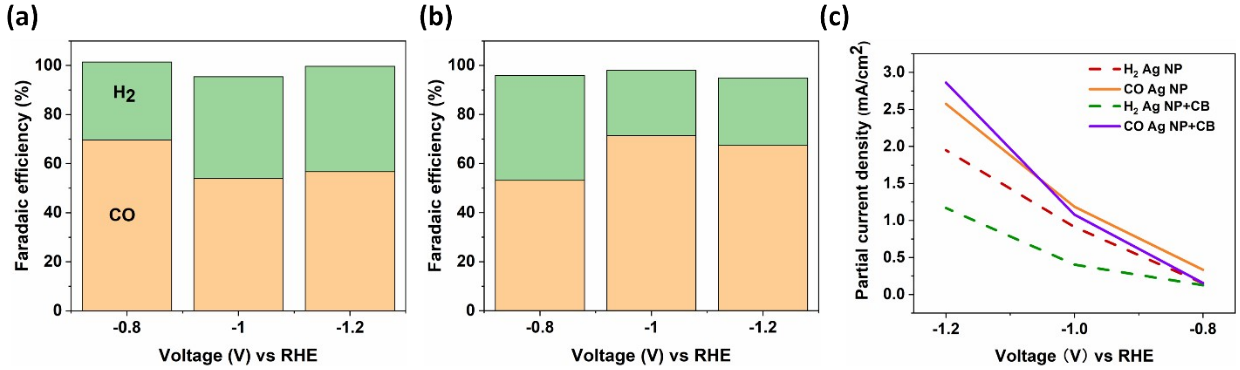

Figure S3. (a) Pure Ag nanoparticles drop casted on glassy carbon electrode tested at H-cell. (b) Ag nanoparticles mixed with carbon black to mimic the Ag/CB catalyst drop casted on glassy carbon electrode tested at H-cell. (c) Partial current density of CO and H_2 from pure Ag nanoparticles and Ag nanoparticles mixed with carbon black.

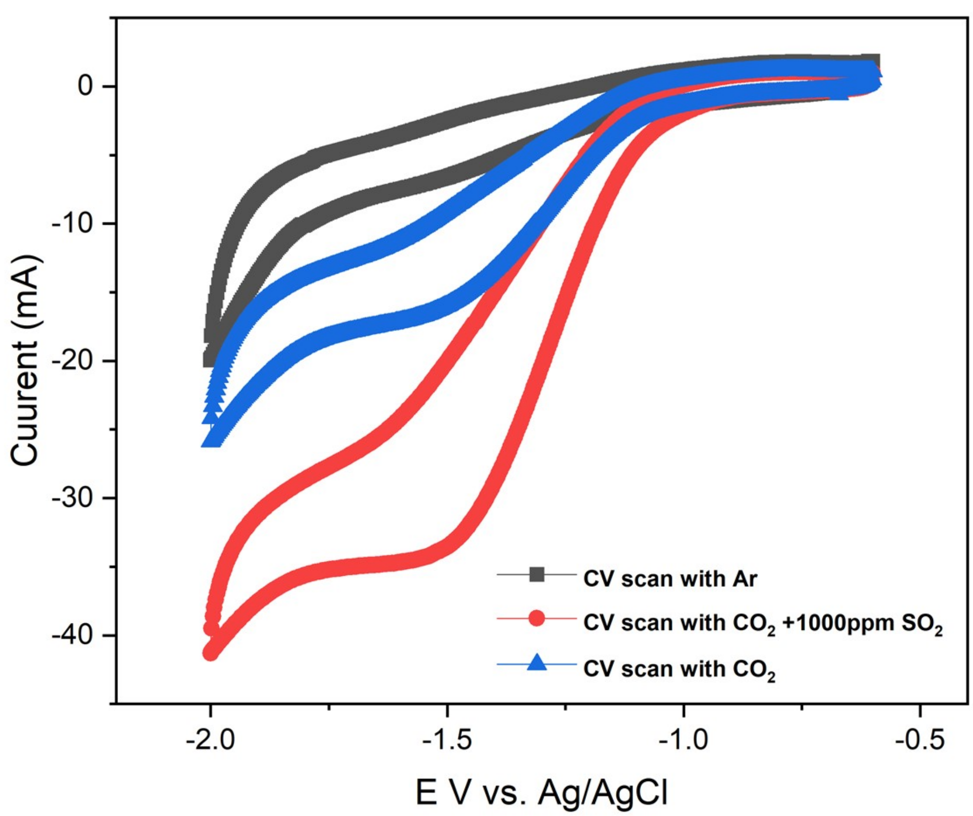

Figure S4. Cyclic voltammetry tests under various gas supplies: pure Ar, CO_2 with 1000ppm SO_2 and pure CO_2

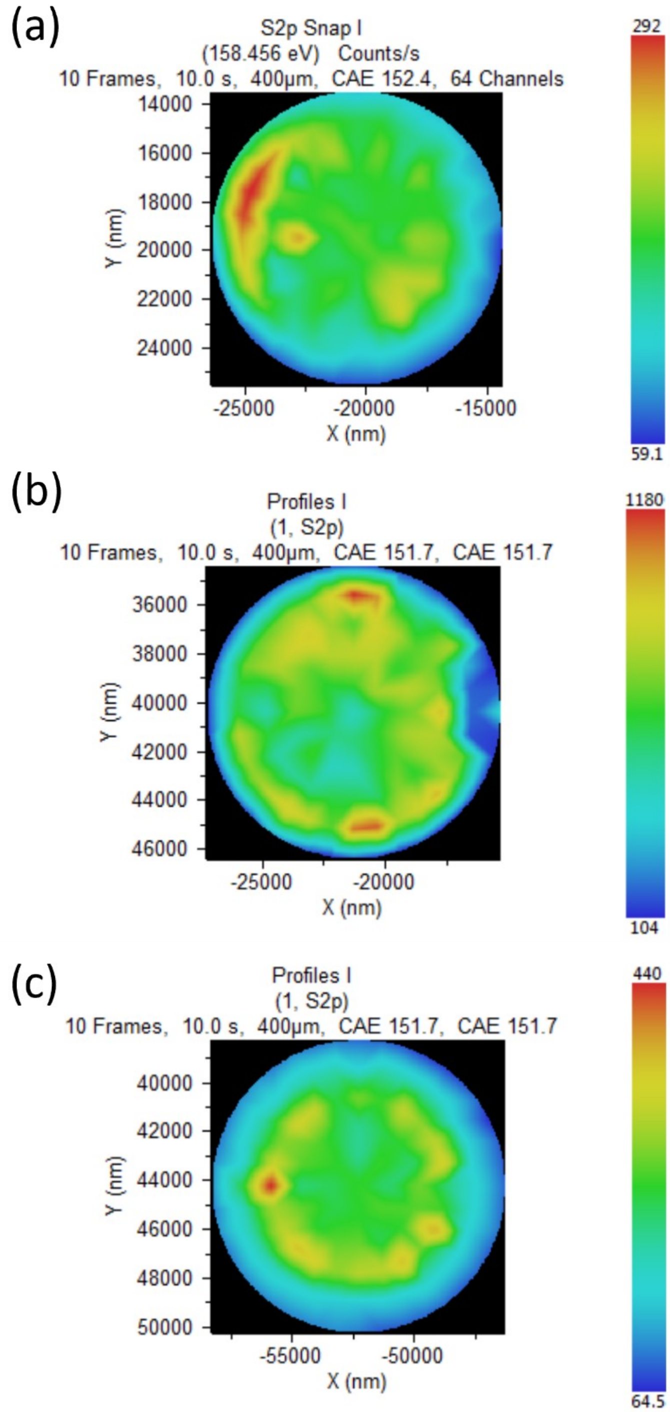

Figure S5. XPS area scan of the Ag/CB catalyst tested at H-cell. (a) uncoated Ag/CB catalyst after 1h CO_2 electrolysis at H-cell with pure CO_2. (b) uncoated Ag/CB catalyst after 1h CO_2 electrolysis at H-cell with 1000 ppm SO_2. (c) 8 cycles SiO_2 coated Ag/CB catalyst after 1h CO_2 electrolysis at H-cell with 1000 ppm SO_2.

Method to calculate the SO_2 concentration required to get SO_2 reduction

$$FE_{missing} = FE_{in\ total\ (Ag/CB\ with\ pure\ CO_2\ feed)} - FE_{in\ total\ (Ag/CB\ with\ CO_2\ +\ SO_2\ feed)}$$

$$FE_{in\ total} = FE_{H_2} + FE_{CO}$$

$$I_{missing} = FE_{missing} \times I_{in\ total}$$

$$I_{SO_2\ RR\ partial\ current} = I_{missing}$$

$$Required\ flow\ rate_{\ SO_2} = \frac{I_{SO_2\ RR\ partial\ current} \times 6.242 \times 10^{18}}{N_{number\ of\ electrons} \times N_A} \times V_{25°C}$$

$$V_{25°C} = \frac{nRT_{25°C}}{P} = 24.465 L/mol$$

$$N_A = 6.02 \times 10^{23}\ mol^{-1}$$

$$N_{number\ of\ electrons} = 6$$

$$Required\ C_{concentration}\ SO_2 = \frac{Required\ flow\ rate_{\ SO_2}}{Flow\ rate_{in\ total}} \times 100\% \times \frac{1 \times 10^6\ ppm}{\%}$$

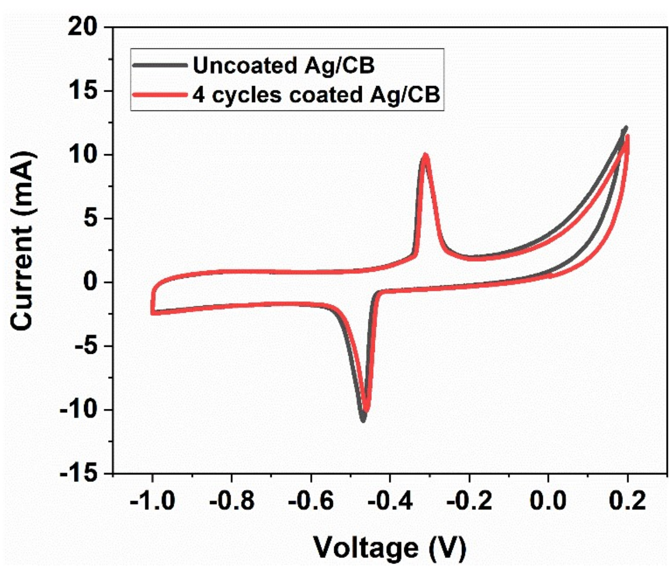

Figure S6. CV testing of the uncoated Ag/CB catalyst and the catalyst with 4 cycles of SiO_2 coating, tested at MEA reactor.

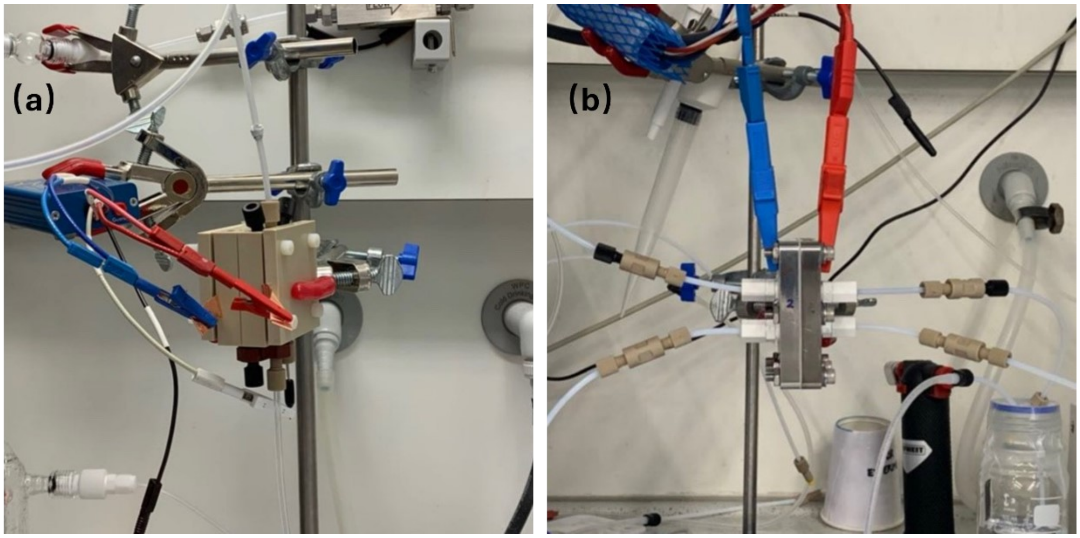

Figure S7. A visual representation of both cell geometries. (a) H-cell (b) MEA

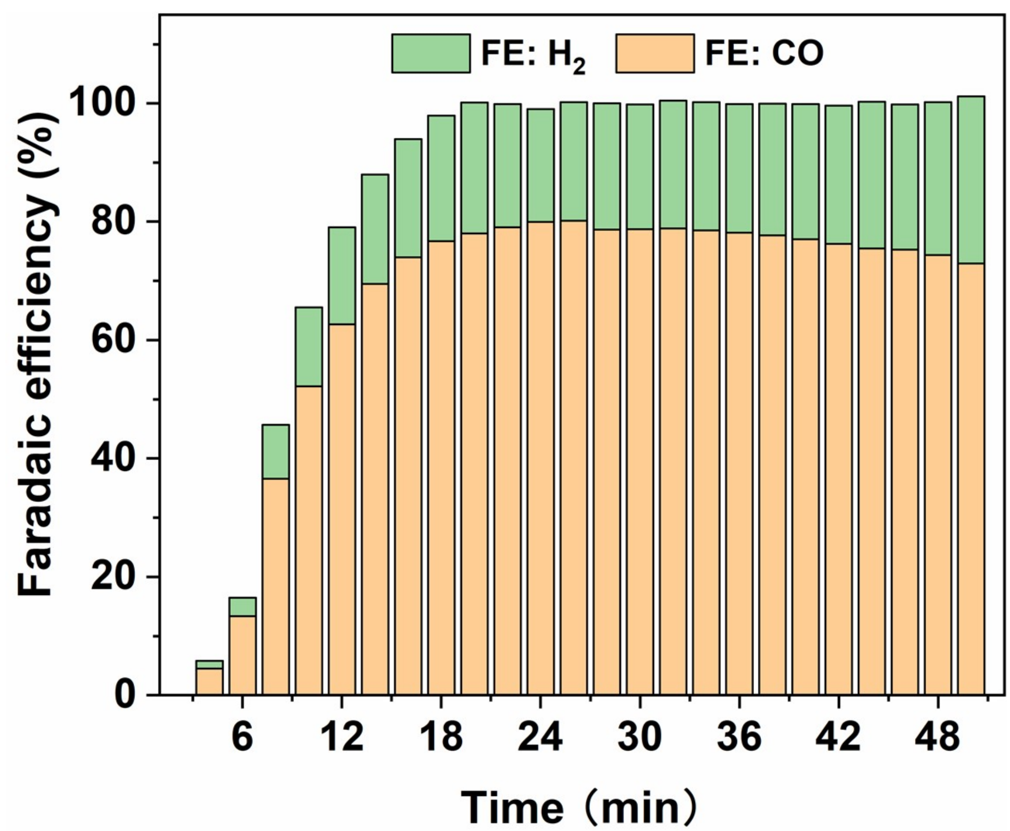

Figure S8. Faradaic efficiency of the original Ag/CB catalyst tested at MEA reactor at 100 mA/cm2 current density in a 1 M KHCO3 electrolyte with pure CO2 feed for 50 minutes.

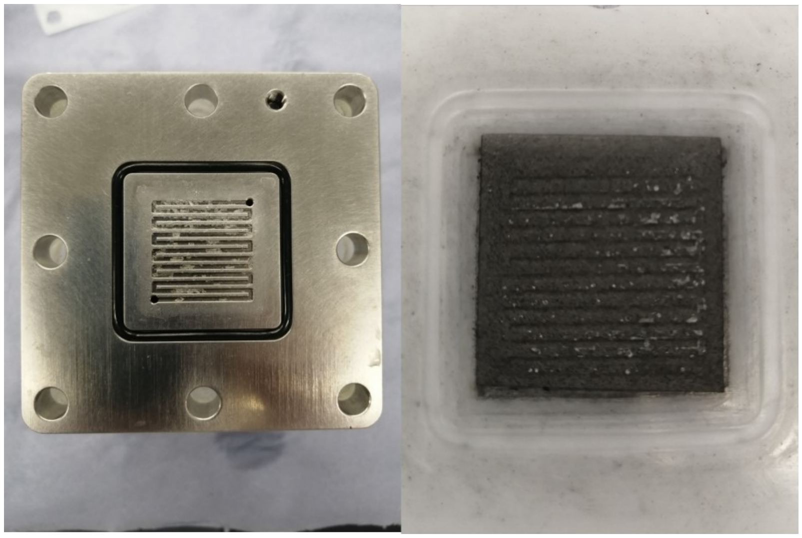

Figure S9. Salt formation after 50 minutes CP testing of the uncoated Ag/CB catalyst at 100 mA/cm^2.

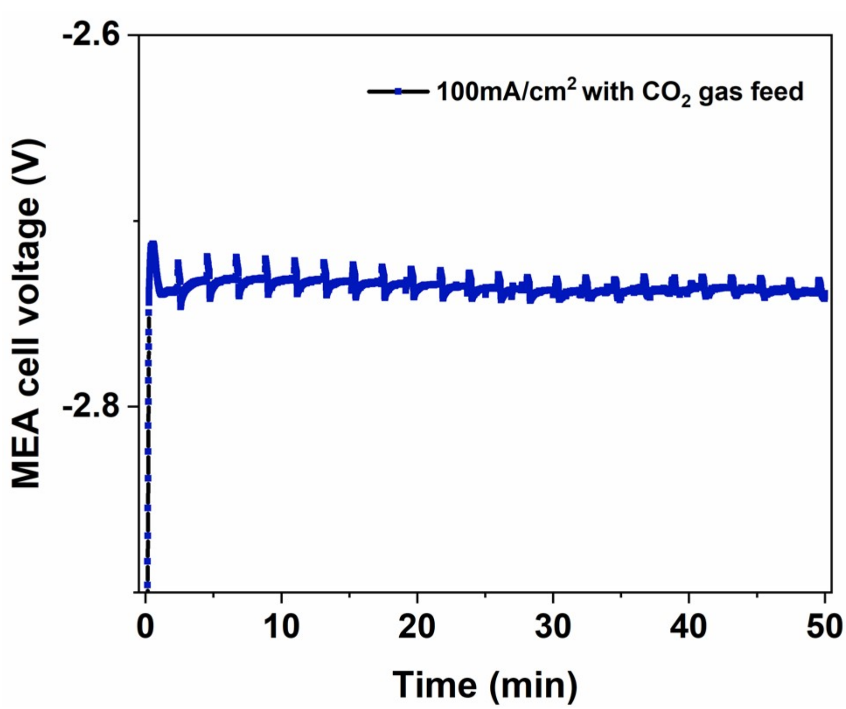

Figure S10. CP testing of the uncoated Ag/CB catalyst with pure CO_2 gas feed at 100mA/cm^2.

Table S1. ALD experimental conditions. (RT indicates room temperature)

Material	Reactant (T,°C)	Co-reactant (T,°C)	Type of reactor	$T_{reaction}$ (°C)	Pulse and Purge Time (s) ($SiCl_4$-N_2-H_2O-N_2)	Flow rate(L/min)
SiO_2	$SiCl_4$ (RT)	H_2O vapor (RT)	Flat substrate reactor	100	15-60-30-60	0.5-0.5-0.5-0.5
SiO_2	$SiCl_4$ (RT)	H_2O vapor (RT)	Fluidized bed reactor	100	60-150-60-150	0.5-2-2-2

Table S2. Gas recipes for H-cell testing and MEA testing

Gas composition	Types of reactors	Gas flow rate (sccm)		
		CO_2	CO_2 + 100 ppm SO_2	CO_2 + 10000 ppm SO_2
CO_2	H-cell	8	0	0
CO_2 + 10 ppm SO_2	H-cell	7.2	0	0.8
CO_2 + 100 ppm SO_2	H-cell	0	8	0
CO_2 + 1000 ppm SO_2	H-cell	7.2	0	0.8
CO_2	MEA cell	20	0	0
CO_2 + 1000 ppm SO_2	MEA cell	18	0	2