Supporting Information

Catalytic CO2 esterification with ethanol for the production of diethyl carbonate using optimized CeO2 as catalyst

Marco Buchmann [a], Martin Lucas [a] and Marcus Rose [a]

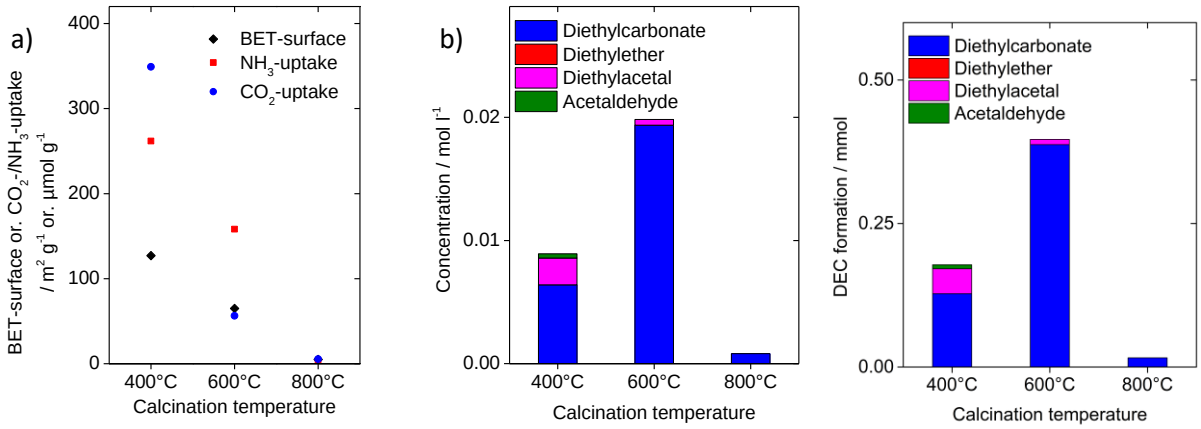


Fig. S1 Comparing the impact of various calcination temperatures of urea precipitated CeO_2 on the a) BET-surface and CO_2-/NH_3-uptake and b) reactivity towards DEC formation (Reaction conditions: 337 mmol ethanol, 0.2g catalyst, 40 bar CO_2, 120°C).

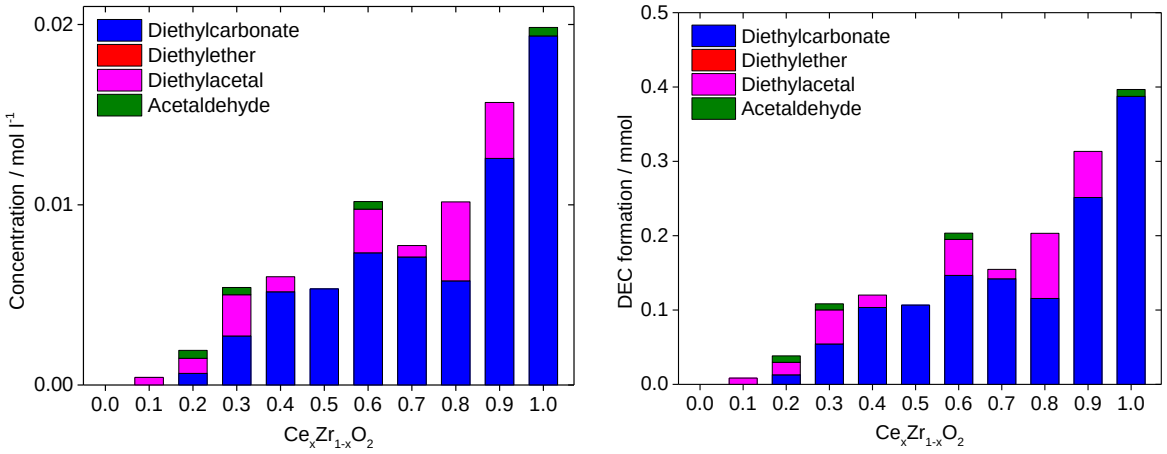


Fig. S2 Comparison of the influence of different Ce:Zr ratios on the catalytic activity towards DEC formation. Reaction conditions: 337 mmol ethanol, 0.2g catalyst, 40 bar CO_2, 4h reaction time, 120°C.

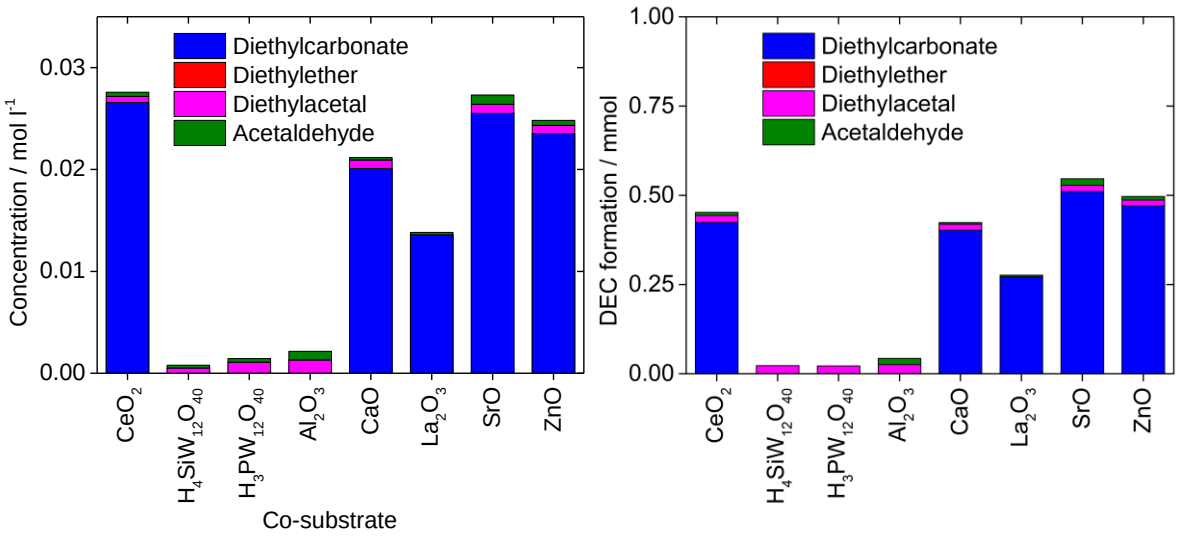


Fig. S3 Influence of various additives ($H_4SiW_{12}O_{40}$ and $H_3PW_{12}O_{40}$) and mixed oxides (Al_2O_3, CaO, La_2O_3, SrO and ZnO) on the reactivity towards DEC formation (Reaction conditions: 337 mmol ethanol, 0.2g catalyst, 4h reaction time, 120°C).

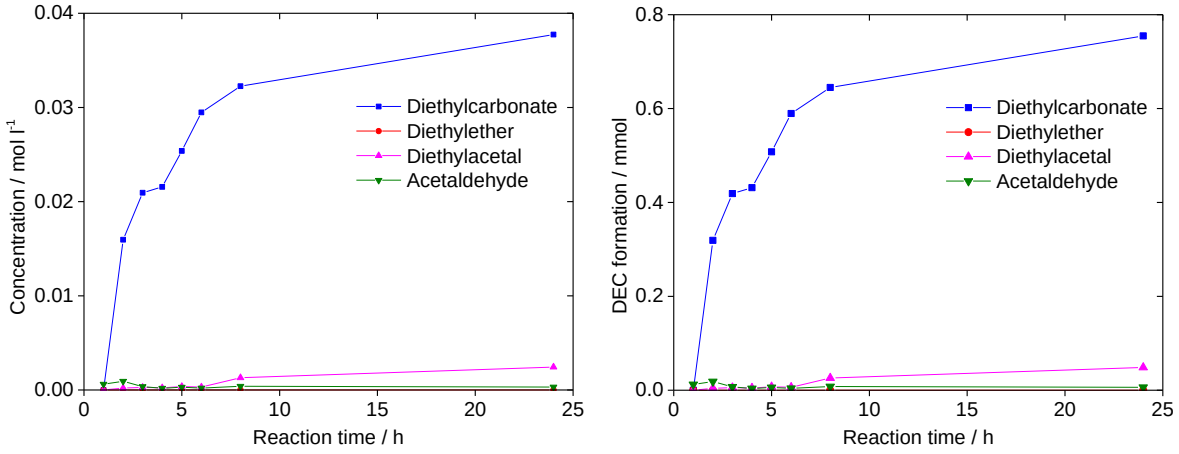


Fig. S4 Influence of reaction time on the DEC formation. Reaction conditions: 337 mmol ethanol, 0.2g catalyst, 40 bar CO_2, 120°C.

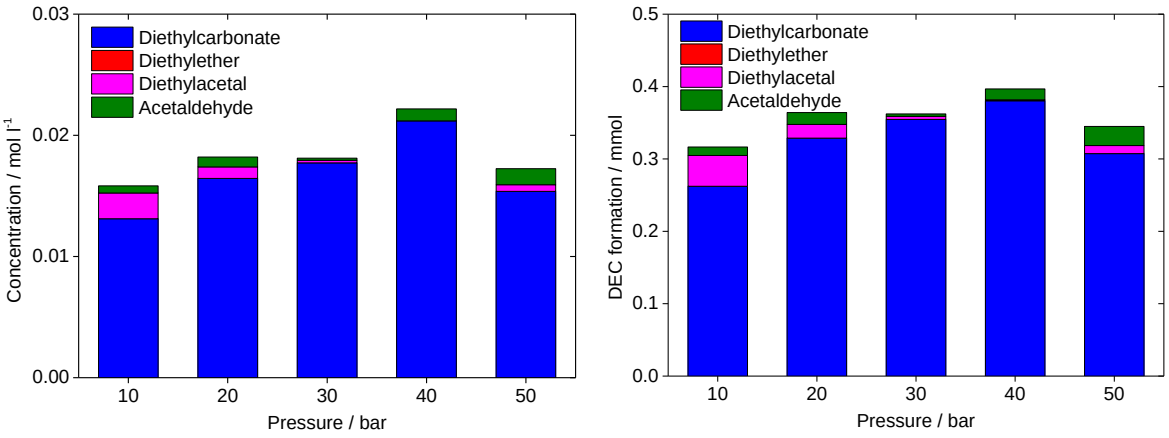


Fig. S5 Influence of the initial CO_2 pressure on the reactivity towards DEC formation (Reaction conditions: 337 mmol ethanol, 0.2g catalyst, 4h reaction time, 120°C).

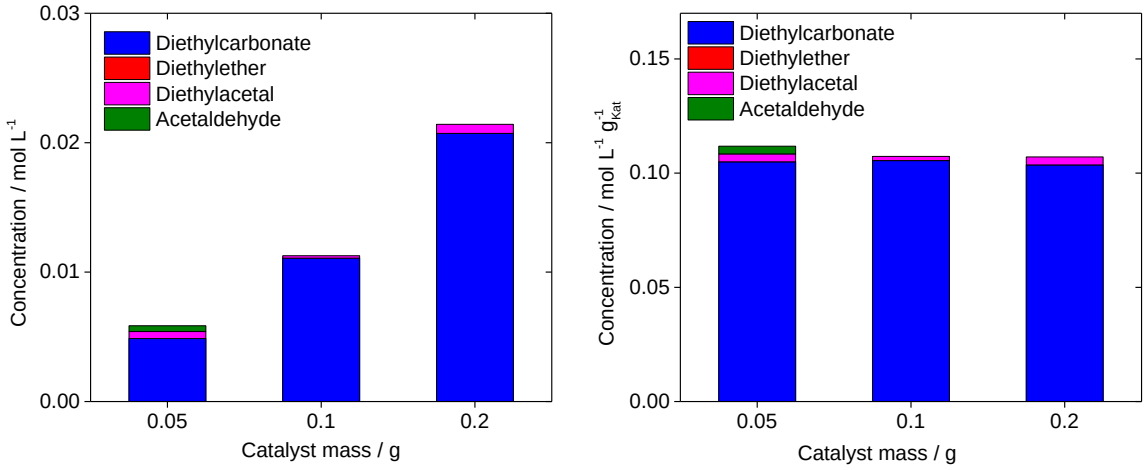
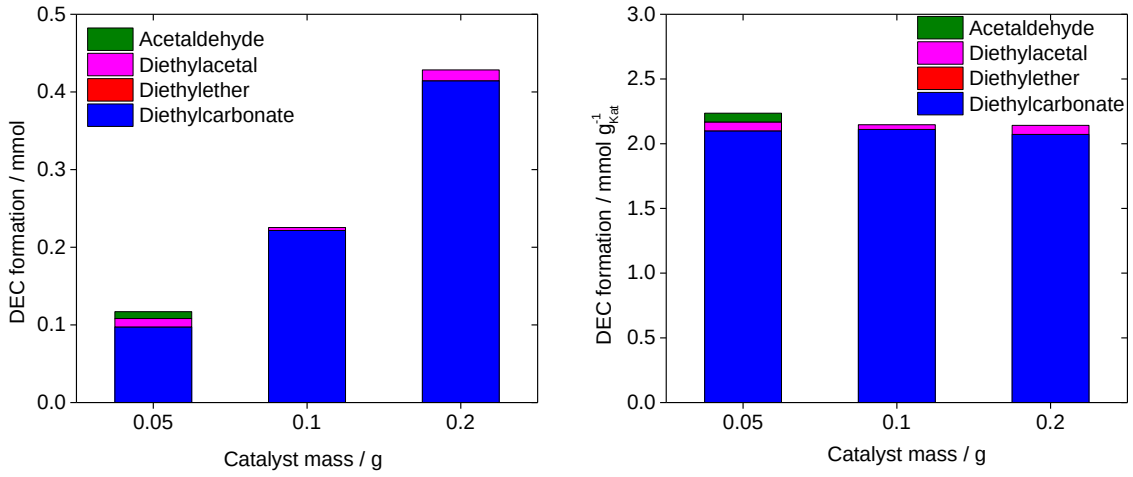


Fig. S6 Influence of the catalyst mass on the reactivity towards DEC formation (Reaction conditions: 337 mmol ethanol, 4h reaction time, 120°C). The right graph shows the same data with the concentration normalized by the catalyst mass.



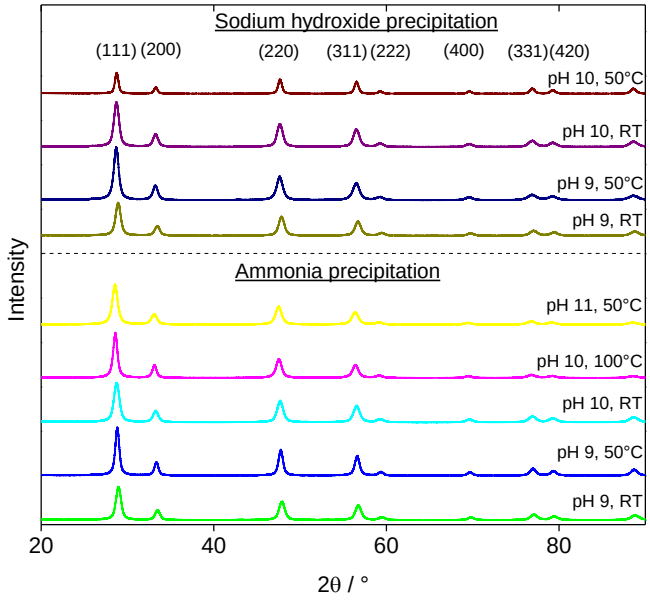


Fig. S7 XRD patterns of catalysts 4-6 and 8-13 all show phase pure CeO_2.

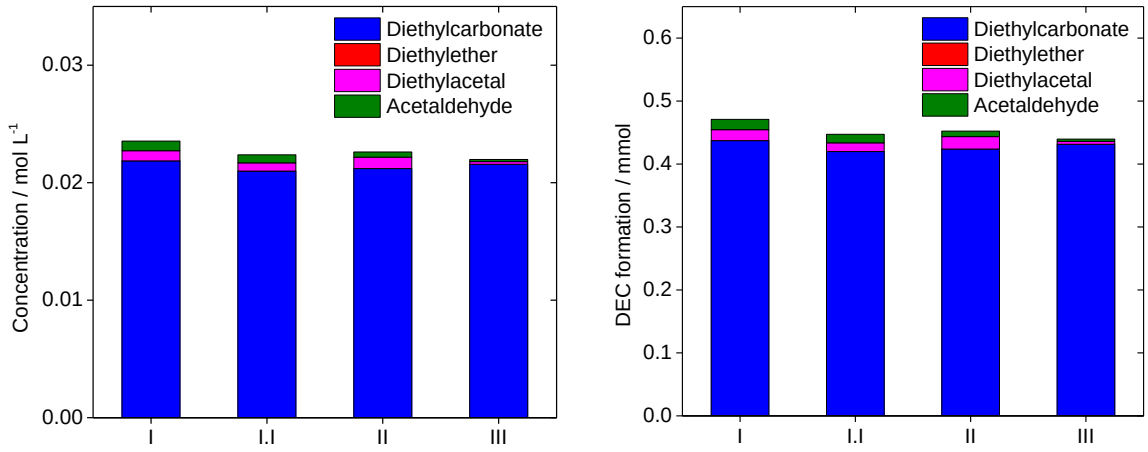


Fig. S8 Reproducibility of catalyst synthesis (I, II, III) and stability of catalytic testing (I, I.I). Catalyst synthesis conditions according to Urea precipitation method, Reaction conditions: 337 mmol ethanol, 0.2g catalyst, 120°C

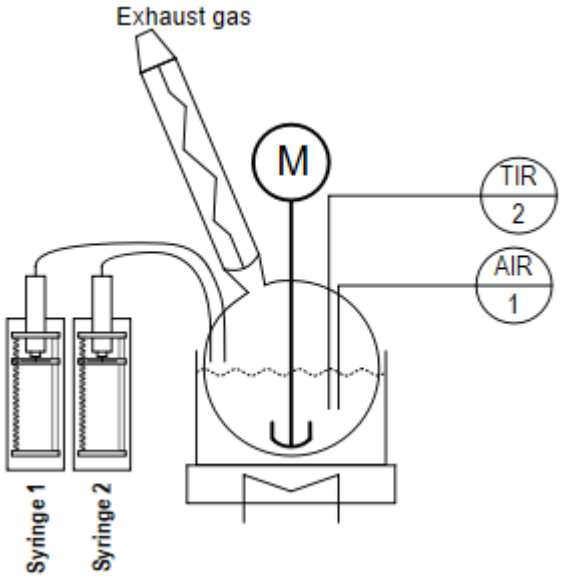


Fig. S9 Detailed scheme for the continuous catalyst preparation setup equipped with two syringe pumps, a pH-electrode, an stirred glass vessel with a mechanical stirrer and a condenser and an oil bath for heating. The precipitation conditions temperature and pH-value were controlled via an in-house lab software. The dosage

Figure S10: Corresponding graphs for Fig. 5-7 with the total amount of products in mmol: