

# Electrochemical deposition of Sn and Bi onto Gas Diffusion Electrodes for the electrochemical CO<sub>2</sub> Reduction Reaction

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## Supplementary Information

Reference in manuscript	Electro- deposition	Catalyst	GDE	FE Formate, %	Potential, V	Current density, mA.cm <sup>-2</sup>	Time on stream, h
[20]	Yes	Ultra-thin Bi <sub>2</sub> O <sub>3</sub> NS	No	95.1	-1	12.3	5
[21]	Yes	Bi NS	No	92.3	-0.9	13.3	13
[23]	Yes	Bi <sub>2</sub> O <sub>3</sub> nanofoam	Yes	91.7	-1	28.5	100
[42]	Yes	Bi-dendrites/ black P nanosheets	No	92	-1	38.1	5
[43]	Yes	E-beam deposited Bi	No	89	-0.74	2.7	12
[44]	Yes	Bi	No	91.8	-0.8	10	1
[45]	Yes	Bi nanosheets	No	87	-0.86	5	8
[46]	Yes	Bi/Cu	No	91.3	-1.7	6	2
[47]	Yes	Bi <sub>2</sub> O <sub>2</sub> CO <sub>3</sub> nanosheets	No	86	-1.1	16.5	20
[50]	Yes	Bi nanosheets	Yes	85	-1	125	24
[51]	Yes	Sn NP	Yes	78	-1.2	88	4
[52]	Yes	Bi <sub>2</sub> O <sub>2</sub> CO <sub>3</sub> -Bi- carbon paper	No	89	-1.07	20	10
[14]	No	Bi-NS	No	89.8	-1.74	24	10
[26]	No	Sn	Yes	74	-0.6	214	
[28]	No	Sn-NP	Yes	70	-1.5	150	
[37]	No	Sn-NP	Yes	84	-2.5		
[40]	No	Bi	Yes	70	-2.5	300	
[41]	No	Bi-NS	No	95.5	-1.1	16.5	10
[58]	No	CNT-Bi	Yes	85	-1	150	24
[72]	No	Sn	Yes	76	-1.4	100	6

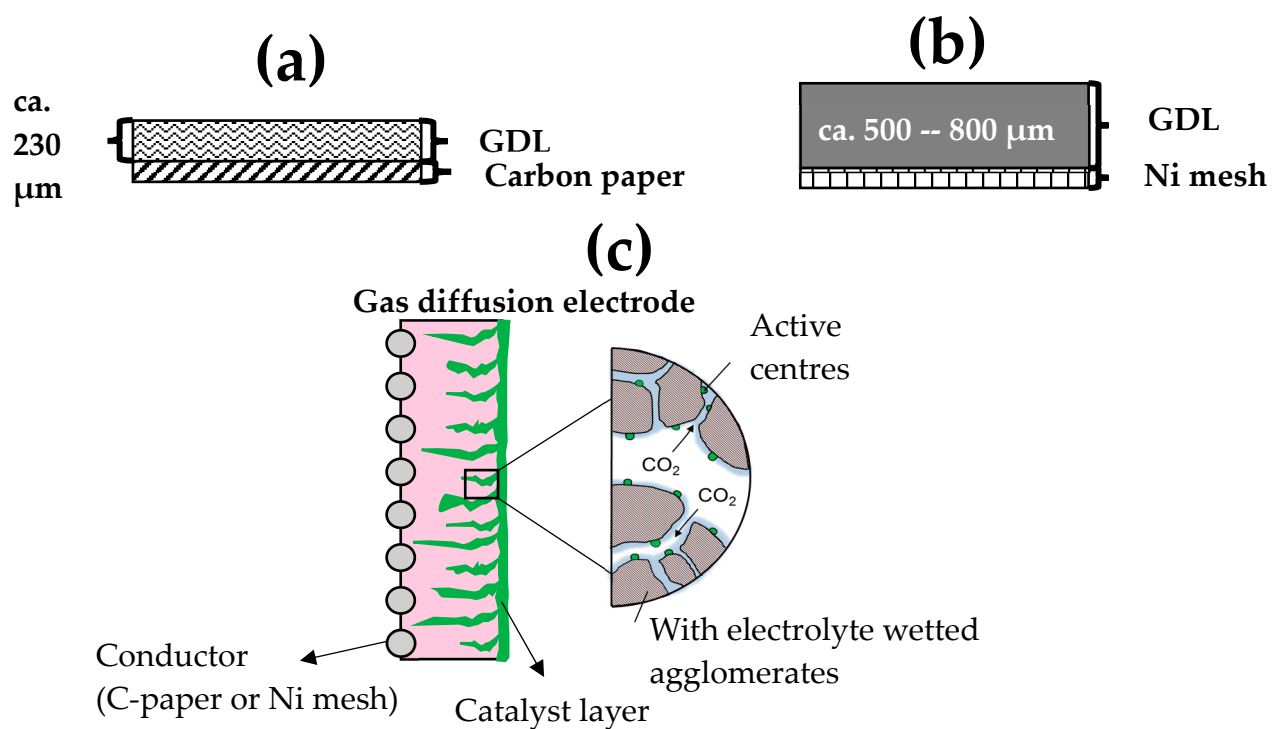


Figure S1. Schema of GDEs. a) commercial GDL 29 BC; b) in-house fabricated GDL; c) GDE - GDL with electrodeposited catalyst.

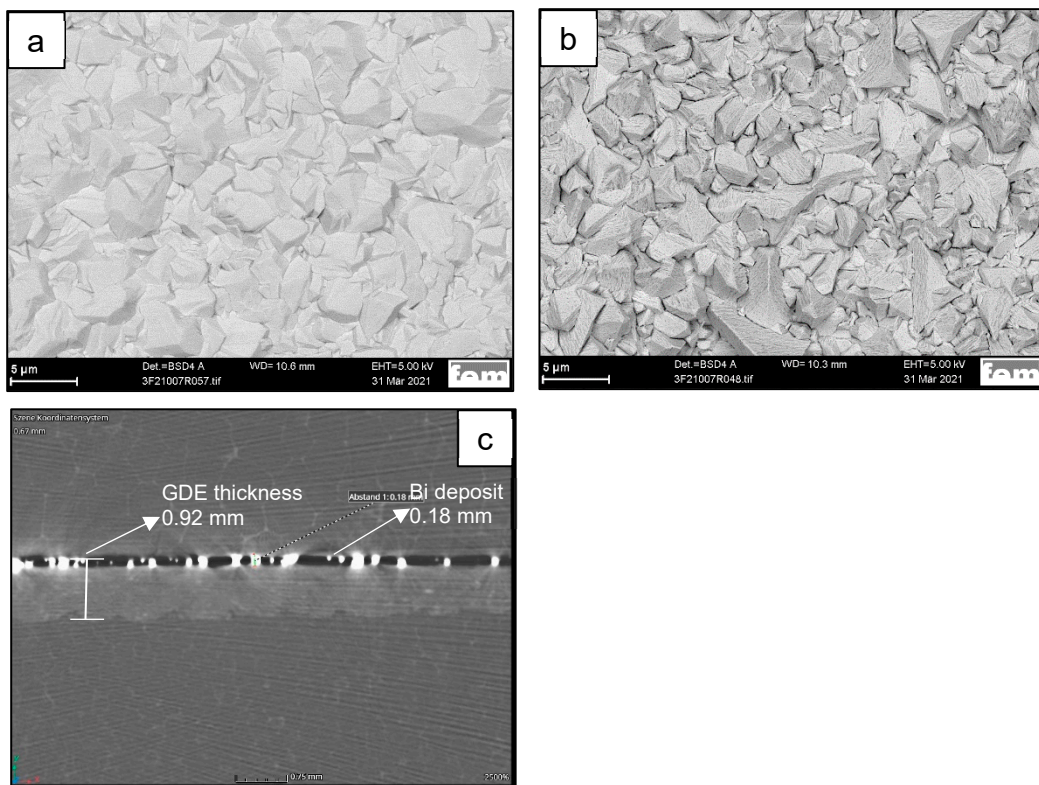


Figure S2. Investigations of Bi-IH-PP GDEs. a) SEM image of Bi-IH-PP, Bi-10-11-15; b) SEM image of Bi-IH-PP, Bi-5-11-30 c) CT image of Bi-IH-PP, Bi-5-55-140.

Table S2. Potentials of the electrodes shown in Figure 1 (1-6)

Electrode	Potentials vs. SHE, V (average value 1 h)
Fig. 1 (2)	-1.47
Fig. 1 (4)	-1.38
Fig. 1 (6)	-1.31

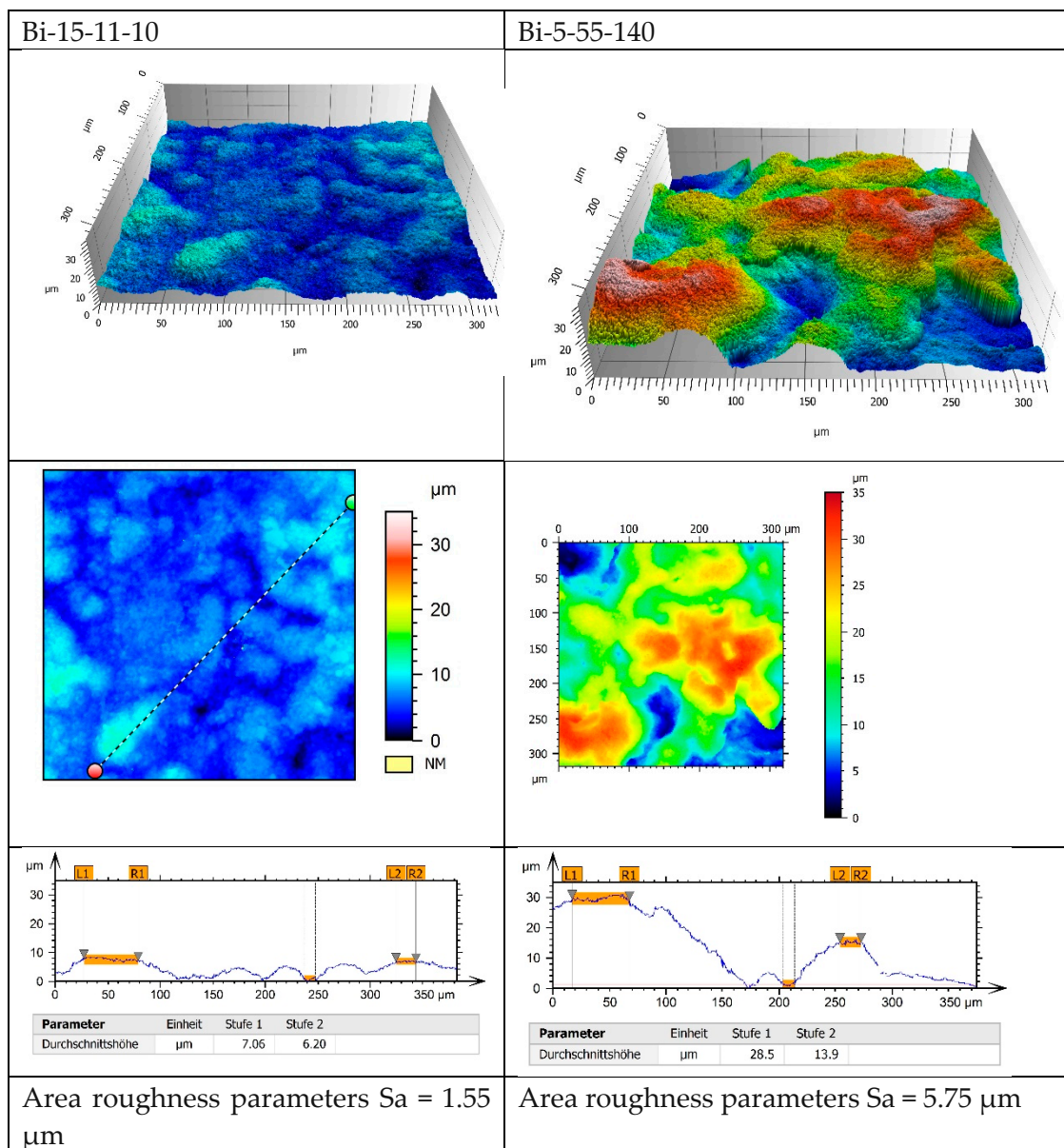


Figure S3. Investigations of Bi-IH-PP GDEs. a) SEM image of Bi-IH-PP, Bi-10-11-15; b) SEM image of Bi-IH-PP, Bi-5-11-30 c) CT image of Bi-IH-PP, Bi-5-55-140.

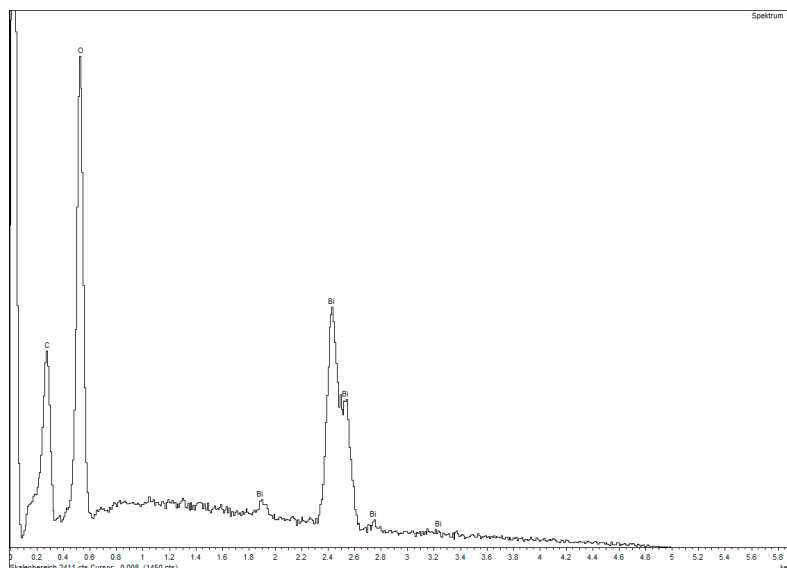


Figure S4. EDX-spectra of Bi-IH-PP, Bi-5-55-140 GDE after eCO<sub>2</sub>RR at 200 mA·cm<sup>-2</sup>, 50°C, 60 min.

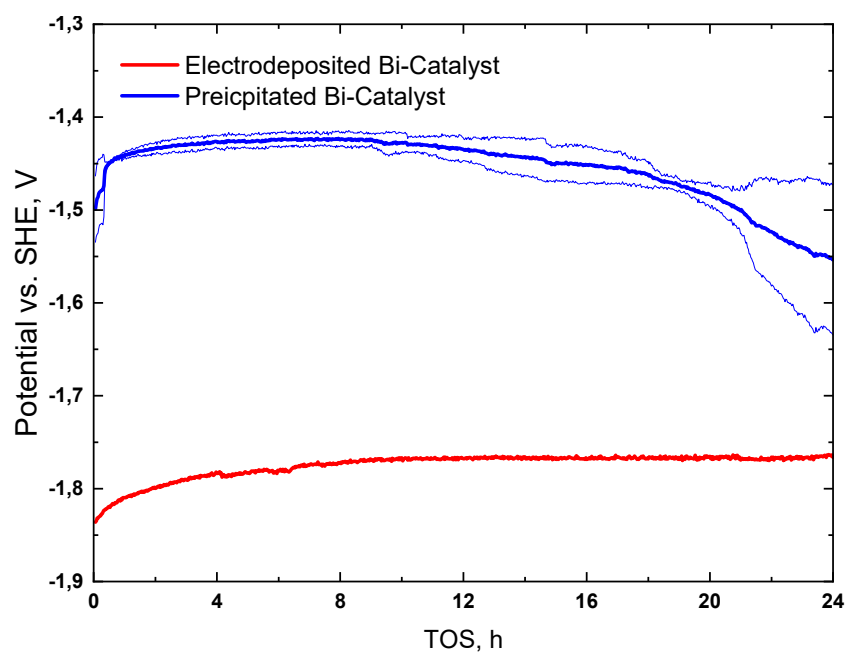


Figure S5. Potentials of Fig 4. Potentials of Bi-IH-PP GDE, Bi-5-55-140 (blue) with Bi-IH-P GDE (red). Tested at  $200 \text{ mA} \cdot \text{cm}^{-2}$ ,  $50^\circ \text{C}$ , 24 h.



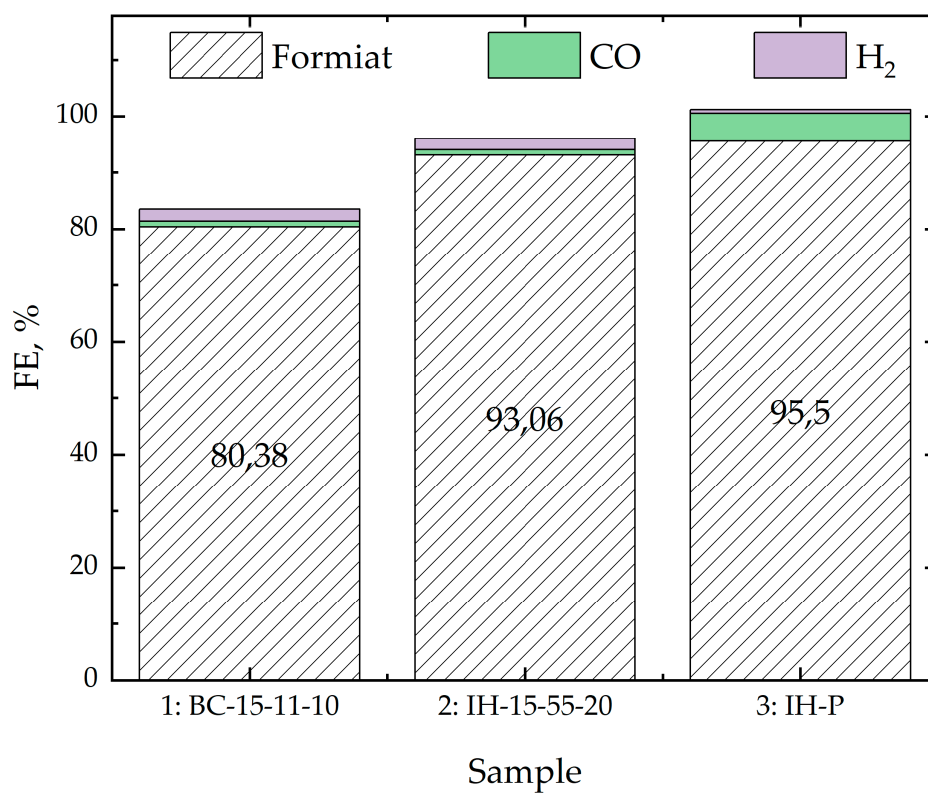


Figure S6. FE for formate and product distribution for electrodes with electrodeposited catalysts Bi-BC-PP (15-11-10) in column (a); electrodeposited catalysts Bi-IH-PP (15-55-20) in column (b) and an electrode with precipitated Bi catalyst in column (c). Electrochemical tests conditions: 200 mA·cm<sup>-2</sup>, 50 °C, time on stream (TOS): 60 min.

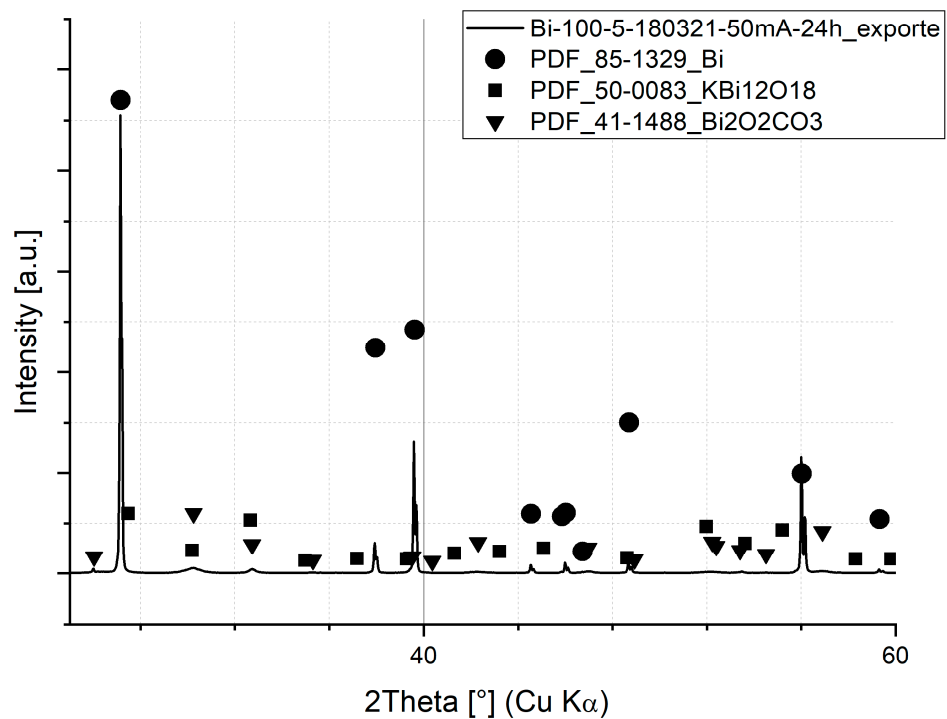


Figure S7. XRD measurements of Bi-BC-PP GDE Bi-15-11-10 after eCO<sub>2</sub>RR (50 mA·cm<sup>-2</sup>, 50 °C, 24 h).

Table S3.: Potentials of the electrodes shown in Figure 5 (a-c)

Electrode	Potentials vs. SHE, V (average value 1 h)
Fig. 5 (a)	-1.57
Fig. 5 (b)	-1.62
Fig. 5 (c)	-1.53

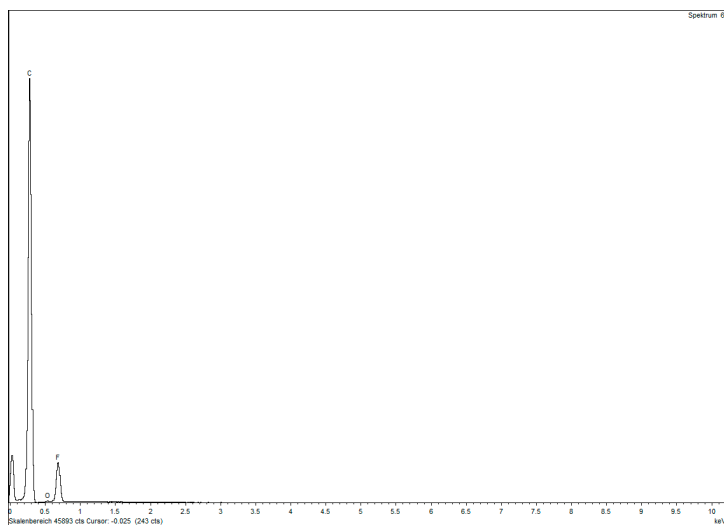


Figure S8 a. Spectra 6.

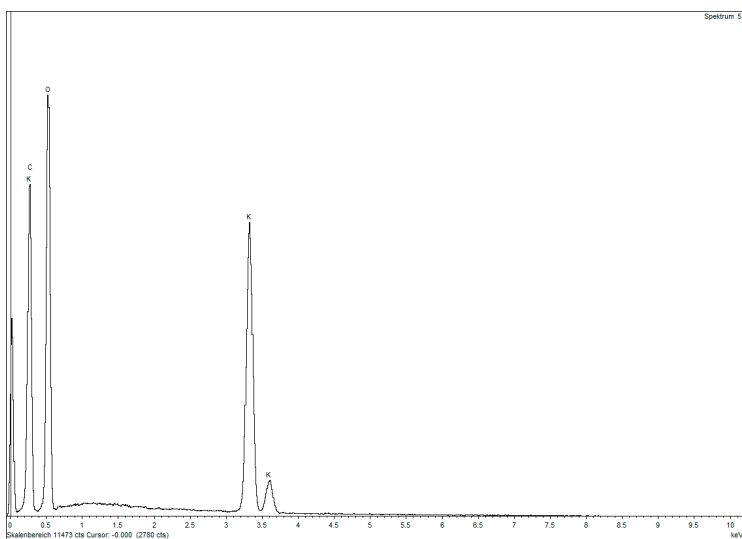


Figure S8 b, spectra 5.