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Investigation of the Electrochemical Ethylene Glycol Oxidation using Ni-based Layered Double Hydroxides

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Plastic waste has become indispensable in our daily lives and in industry. Post-consumer plastic waste has increased to 260 Mt of waste annually over the last decades, making up approximately 2% of the global CO_2 emission. Polyethylene terephthalate (PET) is one of the most used plastics and accounts for around 13% of annual plastic production. Unfortunately, only 20% of PET waste is recycled, neglecting opportunities given by chemical recycling. PET can easily be recycled by alkaline hydrolysis yielding ethylene glycol (EG) and terephthalic acid (TA) both of which can either be used as monomers for newly produced high-quality PET or transformed into other relevant chemicals for industry. Alkaline electrochemical oxidation of ethylene glycol (EGOR) can convert EG obtained from PET hydrolysate into an industrially relevant formate source.[1-4]
This work investigates the influence of electrochemical catalyst pretreatment on the EGOR utilizing inexpensive and highly tunable Ni-based layered double hydroxides (LDH) to promote efficient formate production. Results show good catalytic activity for EGOR, showcasing onset potentials of as low as 1.28 V *vs.* RHE. Electrolysis experiments applying cyclic voltammetry pretreatment result in an increase in yield for NiMn und NiCo LDH reaching yields of 30.7% formate at >80% Faraday efficiency at 1.40 V *vs.* RHE over 2 h in an unoptimized cell. These results equal an increase in yield of over 10%points compared to experiments without pretreatment. Chronoamperometric pretreatment only showed minor improvement using NiMn LDH and no change or a decrease in performance using Ni, NiCo LDH and NiFe LDH compared to electrolysis without prior catalyst pretreatment. *In situ* infra-red measurements were used to investigate the mechanistic differences between the LDH materials indicating superior C–C bond cleavage activity of NiMn and NiCo LDH compared to the other tested materials.[5,6]
In conclusion, our study highlights the potential of Ni-based LDH materials for EGOR to reduce PET waste by utilizing chemical recycling. Additionally, the potential of electrochemical pretreatment for industrial application is showcased, increasing productivity and optimizing catalyst performance.

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