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Power-to-X Applications Performed by Atmospheric Microwave Plasma Torches

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“Power-to-X” is a general term summarizing technologies for conversion of surplus energy from renewable sources into matter that either can be stored and reconverted when required, or that will serve as basic materials for the production of e.g. more complex substances in chemical industry or synthetic fuels replacing fossil fuels in the transport sector.
Carbon dioxide (CO_2) conversion is a promising approach for storing surplus renewable energy. The concept of CO_2 conversion is based on splitting CO_2 into oxygen (O) and carbon monoxide (CO) radicals in an atmospheric pressure plasma process. Highly energetic atmospheric microwave plasma torches, using excess electrical energy from regenerative sources, were applied for efficient CO_2 dissociation. By separation of the oxygen from the gas mixture via a perovskite membrane, the purity of the remaining CO gas is sufficient for conversion into syngas or higher hydrocarbons. The combination of methane (CH_4) and CO_2 conversion is an efficient means for the production of syngas, too. The H_2/CO mole ratio of the syngas is relatively easy to control by adjusting the ratio of CO_2/CH_4 during the feeding process, while additional application of a suitable catalyst can significantly enhance the process efficiency.
The same atmospheric microwave plasma torches were used for decomposition of alcohols like methanol and ethanol to hydrogen in a water vapour plasma discharge. In fact, nearly 100% decomposition of methanol can be achieved in an atmospheric microwave plasma process. The steam reforming reaction $C_2H_5OH + H_2O \rightarrow 2CO + 4H_2$ is the most likely source of H_2 production in this case, which is confirmed by the fact that no formation of solid carbon was observed. H_2 produced by this kind of atmospheric microwave plasma processes is a practical means for storing electrical energy from renewable sources.

Keywords
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