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A microwave plasma torch for CO2 conversion

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Mankind nowadays is strongly affected by the ongoing climate change which is caused mainly by the increasing emission of carbon dioxide (CO_2) from e.g. traffic, coal power plants and industry. An inherent problem of the energy production by renewable sources such as photovoltaics and wind mills is the often observed discrepancy between actual energy "production" and energy demand, due to their discontinuous availability. The so-called "excess" energy can be used to operate a microwave plasma torch at atmospheric pressure. The CO_2 plasma leads to the formation of carbon monoxide (CO) and oxygen radicals ($O^{\bullet}$). To avoid the thermodynamically forced recombination of both back to CO_2, when leaving the plasma state an effective separation process is required. The separation is achieved by ceramic hollow fibers. Firstly, preliminary test with single fibers consisting of different chemical compositions are tested for their oxygen permeation and thermal behavior in the plasma as well as for the brittleness of ceramics by temperature loads. To increase the amount of the separated oxygen several fibers are collected in arrays. The remaining CO in the afterglow can be used as an important chemical C_1 -building block, which can be further employed for creating molecules with a higher commercial value.
This work is focused on the conversion and energy efficiency of the CO_2 plasma by different process parameters like microwave power, gas flow and distance from inside the plasma to the afterglow. The efficiencies are determined via FT-IR and mass spectrometry.

Keywords
Atmospheric plasma torch
CO2 conversion- and energy efficiency
Mass spectrometry
FT-IR
Oxygen separation