Electrocatalytic Conversion of Carbon Dioxide to Methane and Methanol on Transition Metal Surfaces

Fuels and industrial chemicals that are conventionally derived from fossil resources could potentially be produced in a renewable, sustainable manner by an electrochemical process that operates at room temperature and atmospheric pressure, using only water, CO2, and electricity as inputs. To enable this technology, improved catalysts must be developed. Herein, we report trends in the electrocatalytic conversion of CO2 on a broad group of seven transition metal surfaces: Au, Ag, Zn, Cu, Ni, Pt, and Fe. Contrary to conventional knowledge in the field, all metals studied are capable of producing methane or methanol. We quantify reaction rates for these two products and describe catalyst activity and selectivity in the framework of CO binding energies for the different metals. While selectivity toward methane or methanol is low for most of these metals, the fact that they are all capable of producing these products, even at a low rate, is important new knowledge. This study reveals a richer surface chemistry for transition metals than previously known and provides new insights to guide the development of improved CO2 conversion catalysts.