Dissociative adsorption of CO_2: The role of the steps

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Due to the urgent problem of global warming, a demand of reducing the release of the greenhouse gas CO_2 into the atmosphere has emerged. A potential approach to limit the CO_2 release is to convert it into useful chemical products, such as methanol, instead of releasing it into the atmosphere. However, the recycling of CO_2 is a challenging task as the molecule is rather inert, which makes it difficult to activate for reduction and subsequent hydrogenation. The most used metal for this activation is Cu, and, hence, a fundamental understanding of how CO_2 interacts with Cu surfaces would promote the development of new catalysts for the reduction of CO_2 [1].

We have previously studied the CO_2 interaction with a Cu(100) surface using Ambient Pressure X-ray Photoelectron Spectroscopy [2], and the analysis, supported by Density Functional Theory (DFT) calculations [3], strongly indicates that the steps on the surface are responsible for the CO_2 adsorption and the subsequent dissociation.

In the present contribution we confirm experimentally the importance of steps using APXPS, exposing a stepped Cu(911) surface to CO_2 at elevated pressures. We observe that CO_2 chemisorb as the activated species $CO_2^{-\delta}$ on the surface, and dissociates forming adsorbed atomic oxygen and CO that desorbs. We demonstrate that the CO_2 adsorption is significantly facilitated by the presence of the steps on the Cu(911) surface as compared to the flat Cu(100). The effect of the facilitated CO_2 adsorption on the subsequent dissociation will be discussed.

References:
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