MASS SPECTROMETRIC ANALYSIS OF CO_2/AR AND CO/AR PLASMA IN A RADIO FREQUENCY DISCHARGE

Laura F. Spencer and Alec D. Gallimore
University of Michigan, 1320 Beal Ave
Ann Arbor, MI 48109 USA

In recent years, carbon dioxide (CO_2) plasma discharges have gained considerable interest due to rising concerns of global climate change. The increasing dependence on fossil fuels to serve as the world's primary energy source has lead to nontrivial effects on the overall CO_2 content in the atmosphere. One possible solution to mitigating the effects of high atmospheric concentrations of CO_2 is the use of a plasma source to break apart the molecule into carbon monoxide (CO) and oxygen. The CO can be filtered out for use in the chemical industry and as a fuel in industrial applications, or CO can be further dissociated to produce carbon and oxygen.

This work experimentally investigates the dissociation of CO_2 and CO in a 1 kW radio frequency plasma source operating at 13.56 MHz in the low pressure regime of about 100-300 mTorr. Mass spectrometry, optical emission spectroscopy, and x-ray photoelectron spectroscopy diagnostics are used to determine the species present in the discharge. For plasma-assisted CO_2 dissociation to be a practical and cost-effective solution for the climate change challenges, the process must meet certain standards of energy efficiency. Therefore the energy efficiency of the radio frequency plasma source is examined for both CO_2 and CO dissociation, and is determined too low for large-scale industrial applications. Improvements must be made to enhance the energy deposition into specific modes of dissociation through changing the type of plasma source and/or adding a catalyst into the system to increase the rate of dissociative reactions.

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