2nd prize in International conference on sustainable energy technologies (12-13 September, 2017)

Dr. Shamsa Munir, Assistant professor Chemistry department, received 2nd prize in theme based poster competition at “International conference on sustainable energy technologies” held at Serena hotel Islamabad from 12-13 September 2017.

The Conference was organized by US-Pak Center of Advance Studies in Energy, UET Peshawar(USPCAS-E).

Some glimpses of the events:


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International Conference on Sustainable Energy Technologies

Electrocatalytic Reduction of CO_2 to Produce Higher Alcohols

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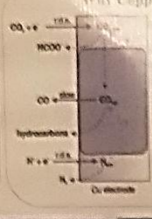
International Conference 2017
SUSTAINABLE ENERGY TECHNOLOGIES

Introduction

CO_2 can be reduced to produce variety of useful compounds including CO, CH_4, HCOOH, C_2H_4 and alcohols such as C_2H_5OH, CH_3OH and $CH_3CH_2CH_2OH$. However the exact reaction mechanism for the conversion of CO_2 to various products is unknown.

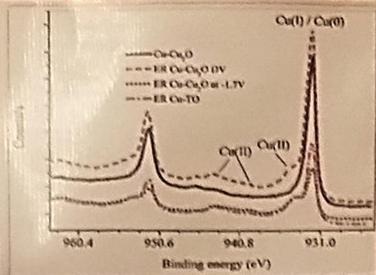
$CO_2 + 6e + 6H^+ = CH_3OH + H_2O$
$2CO_2 + 12e + 12H^+ = CH_3CH_2OH + 3H_2O$
$3CO_2 + 18e + 18H^+ = CH_3CH_2CH_2OH + 5H_2O$
$2CO_2 + 8e + 8H^+ = CH_3COOH + 2H_2O$
$CO_2 + 2e + 2H^+ = HCOOH$

Why Copper and Copper oxides?



Cu surfaces have moderate adsorption of CO as compared to other metals (Ni, Fe, Pt, Ti). Weak or too strong adsorption fails to reduce CO to hydrocarbons and fuels

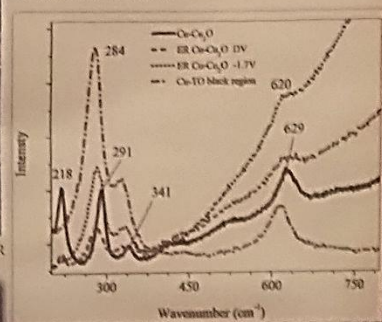
$2CO + H_2O + 8e^- \rightarrow CH_3CH_2OH + 8OH$



Peak at 934 eV and the satellite features indicate the formation of CuO after ER.

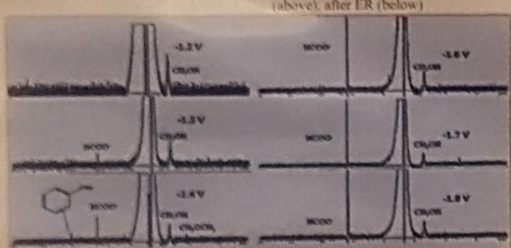
FSEM images of Cu-Cu_2O (a) before ER (b) after ER & Cu-Cu_2O-ZnO (d) before ER (c) after ER.

FSEM images of Cu-ZnO before ER (above), after ER (below)

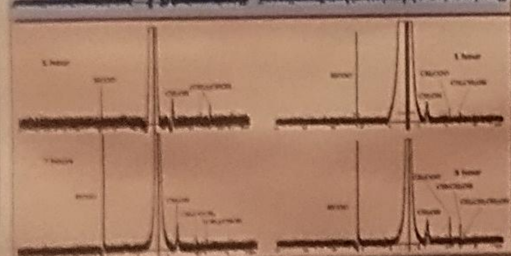


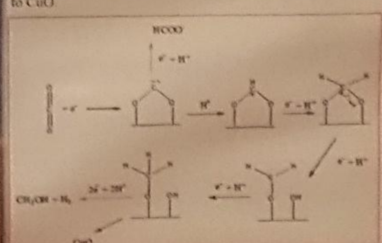
Raman spectra of electrodes confirms the presence of CuO in ER electrodes. The peaks at 284, 334 and 620 cm^{-1} correspond to CuO.

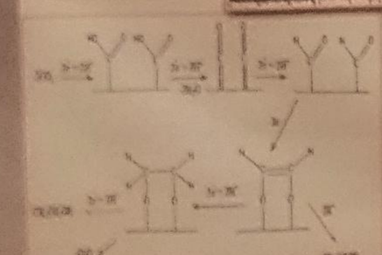
NMR of samples taken after ER of CO_2 using Cu-Cu_2O cathodes in 0.1 M $KHCO_3$. Methanol, ethanol and formic acid were produced with maximum FE [illegible] and [illegible]. FE greater than 100% shows the involvement of chemical steps in the production of methanol.

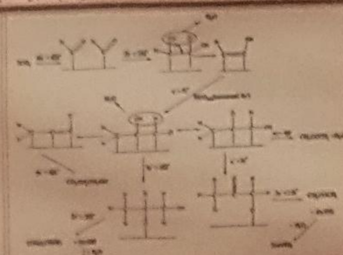


NMR of samples taken after ER of CO_2 at various times using Cu-ZnO (**left**) and Cu-TO (**right**) cathodes and -1.7 V in 0.1 M $KHCO_3$. 2-propanol and acetone are produced with FE of [illegible] and [illegible] while ethanol and acetone with the FE of [illegible] and [illegible] on Cu-ZnO & Cu-TO respectively.









Conclusions

Formation of C1 compounds at Cu-Cu_2O and Cu-Cu_2O-ZnO. Electrodeposited Cu-ZnO was found most efficient to produce higher alcohols (C3) giving a total of 97.4 %. We believe that the chemistry of Cu-Zn interface has a fundamental role in the production of C3 species.

The total FE of 58.51 % was witnessed on Cu-TO matching well with the literature quoted value of 57 %[1]

Methanol formation proceeds via oxygen coordination of CO_2 to Cu-Cu_2O surface having (100) facets, leaving behind Cu(II) oxide at the end.

The localized appearance of ZnO nanoflowers on Cu-ZnO electrode after ER is the result of mechanistic pathways leading to n-propanol and acetone involving a chemical step equivalent to one electron transfer.

Acknowledgment

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