Reusing CO_2 as Fuel: Converting Carbon Dioxide to Ethanol

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Dr. Adam Rondinone is a senior staff scientist at the Oak Ridge National Laboratory's Center for Nanophase Materials Sciences. He received his PhD in chemistry from the Georgia Institute of Technology in 2001 and immediately joined Oak Ridge as a prestigious Wigner Fellow. He is an expert on materials chemistry at the nanoscale, and his research is focused on developing novel means to create functional nanomaterials for energy applications. More recently Dr. Rondinone has explored nanostructured electrochemical catalysts for the conversion of waste to useful products. He has served on various committees in service to ORNL, including 2 years as a Legislative Fellow in the office of Senator Lamar Alexander working on energy and technology issues. He is also the outreach coordinator for the Center for Nanophase Materials Sciences.

Technology

Converting CO_2 to Ethanol

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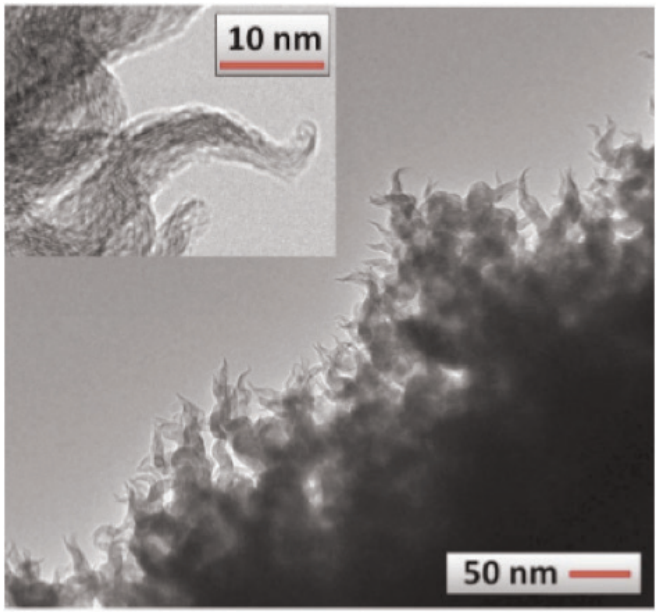
An inherent problem with renewable energy sources is that the amount of energy produced is variable. When too much energy is produced, it must be used or it will be wasted, and when too little energy is produced a secondary source is required. What is needed is a process that can be turned on and off as surplus energy permits and that can produce a useful product. Researchers at ORNL have developed a process for converting CO_2 to ethanol by introducing CO_2 onto a bed of carbon nanospikes and copper nanoparticles that react electrochemically with the CO_2 in the form of bicarbonate, producing ethanol. The process can be terminated and reinitiated at any point, and the yield is greater than the average yield of cellulosic-based ethanol production. This conversion process can be powered by the excess energy produced by renewable sources to reduce both the need for extra infrastructure and the introduction of CO_2 into the atmosphere.

This project was accepted into TIP with two overarching project goals: evaluate the catalyst for performance in the context of typical industrial concerns of lifetime, durability, poisoning, and scale-up; then use that information to estimate the economic viability of the process as a source of fuel ethanol. Additionally, Dr. Rondinone's team is conducting studies to understand efficiency limits and potential improvements.

Applications of this technology are primarily in the areas of fuel production and emergency energy production. Additionally, this method has the potential to be an economically viable alternative to the use of seed crops as precursors to ethanol production.



Publications

- Song, Y.; Peng, R.; Hensley, D. K.; Bonnesen, P. V.; Liang, L.; Wu, Z.; Meyer, H. M.; Chi, M.; Ma, C.; Sumpter, B. G.; Rondinone, A. J., "High-Selectivity Electrochemical Conversion of CO2 to Ethanol using a Copper Nanoparticle/N-Doped Graphene Electrode," *ChemistrySelect* (2016), *1* (19), 6055-6061.
- Sheridan, L.B.; Hensley, D.K.; Lavrik, N.V.; Smith, S.C.; Schwartz, V.; Liang, C.; Wu, Z.; Meyer, H.M.; Rondinone, A.J., "Growth and Electrochemical Characterization of Carbon Nanospike Thin Film Electrodes," *Journal of Electrochemical Society* (2014).