Selective Hydrogen Production from Formic Acid with a Ruthenium Catalyst for Power Generation in Automobiles

Alkhurisi, Mohammed (School: Riyadh School for Boys and Girls)

Hydrogen may play a key future role as a carrier of renewable energy to replace fossil fuel. It could be used in automotive vehicles as it is easy to deliver via the electrolysis of water and is more efficient and cleaner than internal combustion engines. But a drawback of hydrogen is that it is very light; a large volume needs to be compressed in order to run a car. To solve this issue more research is being carried out to use formic acid as a carrier to generate hydrogen in vehicles. Currently, many catalysts are being used to decompose formic acid to hydrogen, but most of them use iridium complexes that are not economically feasible to be employed on a large scale. In this work, I have synthesized a cost-efficient ruthenium-based catalyst with an economically friendly ligand for formic acid dehydrogenation. Its optimum turn-over frequency was determined to be 1,840 h-1 in a 2:1 mixture of sodium formate and formic acid. The activation energy of the process was calculated by measuring the reaction rate at different temperatures, and was found to be 24±0.5Kcal/mol, which is in the range of formic acid decomposition using noble metals. The mechanism was explored by isolating and characterizing a hydride intermediate in the catalytic cycle using 1H NMR. A Horizon Educational Hydrocar was used to demonstrate and confirm the catalyst performance. This outcome shows potential for the catalyst to be used in real vehicles with hydrogen fuel cells implemented as a power source.