Transformation of Waste NO_x to Ammonia

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The clean sole combustion product of H_2 – water only, has caused H_2 to emerge as a critical vector for green energy future in replacement of current fossil fuels. However, the application of H_2 as a fuel and/or energy carriers is still vastly limited by its transportation and storage issue due to its high flammability and gaseous properties under ambient conditions.[1,2] To tackle this, NH_3 has been suggested as one of the most promising energy carriers for H_2 owing to its liquid properties at room temperature and 10 bar, as well as greater hydrogen content compared to H_2 itself.[2] Moreover, the readily available regulations and infrastructure for NH_3 handling and transportation aids the facilitation of global hydrogen economy [2,3] (also referred as Hydrogen 2.0 [4]). Nevertheless, NH_3 today is still mainly manufactured by the non-environmentally friendly and energy intensive Haber Bosch process which utilizes fossil fuels as H_2 feedstock and has contributed significantly to global greenhouse gases emission.[5]

Therefore, herein, the reported finding is to use plasma-electrolyser hybrid system to convert air and water into intermediary NO_x, and subsequently being synthesized into NH_3. [6] This approach provides an opportunity for complete green energy cycle and decentralized local production. The generated NH_3 can be readily used as H_2 fuel via NH_3 splitting or feedstock in industry. Furthermore, it also provides economic opportunity by treating NO_x from powerplants, industries and agricultural waste as resources rather than unwanted emissions.[4] As such, it is critical to develop simple and inexpensive catalysts for effective conversion of NO_x into NH_3. Our research is focused on reducing the levelized cost of NH_3 by lowering cell potential and improving process current density.[4] The ultimate goal is to meet an NH_3 production of 600 $g/m^2/h$ (by CSIRO) to initiate Hydrogen 2.0.[1] To this end, we developed CuO_x/Cu foam catalyst via electrodeposition and demonstrated relatively high NH_3 production rate (42.5 $nmol s^{-1} cm^{-2}$) and Faradaic efficiency (85%) at -0.5 V_{RHE}, exhibiting large attainable NH_3 yield at fairly low applied potential.

References

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