Electroreduction of N_2 to ammonia at ambient conditions using transition metal nitride catalysts

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Ammonia synthesis through the Nobel prize awarded Haber-Bosch process produces around 1.6-3.8 tons of CO_2 per ton of NH_3 produced and the process operates at high temperatures and pressures using H_2 and N_2 as feedstocks, where H_2 is derived from gas/oil/coal reforming. Thus, finding a simple, sustainable, low cost and energy efficient alternative is critically important. In this work, electrochemical nitrogen reduction to ammonia is reported at ambient temperature and pressure in aqueous electrolyte using a thin film zirconium nitride catalyst. Ammonia is synthesized inside an electrochemical micro reactor and measured simultaneously through an in-line connection to ammonia quantification unit. A novel electrochemical technique is introduced to optimize the reaction rate and current efficiency of the nitrogen reduction. Control experiments are run to confirm that ammonia is produced catalytically and not by reacting the inherent nitrogen in the catalyst's structure; these include concentrating the electrolyte with Ar(g) as background test and the use of 15N isotope labelled catalysts. There is a clear difference between the Ar and N_2 experiments and the isotope labelling experiment reveals that within the correct range of applied potential ammonia is produced through electrocatalysis.