Electrosynthesis of ammonia using solid-state proton conductors

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Due to the intermittency of many renewable energy sources, their potential to significantly participate in the overall energy mix is strongly dependent on our ability to identify and develop efficient and cheap energy storage technologies[1]. Liquid fuels are an appealing option with energy densities typically 10-100x higher than batteries. Ammonia, in particular, has many attributes that make it the ideal energy storage compound. The highly developed, large-scale production of ammonia via Haber-Bosh process is not suitable for energy storage applications due to the high-temperatures and pressures used. Theory[2] and experiment[3] suggest that a more suitable approach is the production of ammonia from nitrogen and water via electrosynthesis. The key to efficient electrosynthetic generation of ammonia under mild conditions is the development of suitable electrolytes and catalysts.

Marnellos et al.[3] and Skodra et al.[4] have demonstrated the electrochemical synthesis of ammonia from N_2 and H_2 and H_2O, respectively, using high-temperature proton conductors at atmospheric pressure. In this work, we will demonstrate the electrosynthesis of ammonia and compare several electrode/ electrolyte systems. Specifically, we are investigating the use of the high temperature proton conducting perovskites $SrCe_{0.95}Yb_{0.05}O$ and $BaCe_{0.8}Gd_{0.2}O$. We have reproduced the results of Marnellos et al. using platinum on SCY. The current work focuses on examining other anode and cathode materials in order to improve the rate of NH_3 conversion.

References

1. Report of the Basic Energy Sciences Workshop on Electrical Energy Storage, 2007.
2. T. H. Rod, A. Logadottir and J. K. Nørskov, The Journal of Chemical Physics 112 (12), 5343 (2000).
3. G. Marnellos and M. Stoukides, Science 282 (1998).
4. A. Skodra and M. Stoukides, Solid State Ionics 180 (23-25), 1332-1336 (2009).

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