New Routes of Ammonia Synthesis and Decomposition

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Activating molecular nitrogen is an extremely important process as it supplies, in the form of fertilizer, the nitrogen that is a prerequisite for building all amino acids and nucleic acids essential for life. Ammonia is also considered being an energy vector for storing energy over longer time. It shall be motivated why an alternative route to the current thermal ammonia synthesis route – the commercial Haber-Bosch process - could be attractive in a decentralized electrified society. This will be extended to new routes of promotion of thermal ammonia synthesis (and decomposition) showing how cobalt can also be made very active[1]. The active site will be identified by a combination of cobalt single crystals with and without steps combined with reaction over mass-selected nanoparticles made in situ by a cluster source[2]. We shall also discuss the briefly the cracking of ammonia for making it useable for the shipping industry[3]. In the second part, we shall turn to electrochemical ammonia synthesis where we now have shown how one can make ammonia at ambient conditions. The Li-mediated process will be discussed, and we will show how we over the last 5 years have gone from having a process that did only make very little ammonia[3] to now being capable of obtaining more than 80% Faradaic efficiency and high current densities[4,5]. The scale-up approach will be discussed making grams of ammonia just as characterization of in situ measurements of the dynamic assembly of the solid electrolyte interface (SEI) layer - known from the Li batteries field - is formed, controlling the transport processes[6]. Despite excellent recent progress there are still substantial outstanding questions concerning energy efficiency which will also be discussed[7].

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