Karlsruher Institut für Technologie

Institut für Technische Chemie und Polymerchemie
Lehrstuhl für Chemische Technik
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Karlsruhe, 11.10.2016

Vergabe einer Studentische Hilfskraft (Hiwi) / Werkstudent(in)

Title:

Experimental investigation of NH_3 production using steam and N_2 in a high temperature proton-conducting Solid Oxide Electrolysis Cell (SOEC)

Description:

Solid Oxide Cells (SOC) are one of the leading members of the new brigade of clean and sustainable energy devices. They are highly-efficient solid state electrochemical devices capable of either directly converting fuel (H_2, CO, etc.) into electrical energy and clean product (H_2O, CO_2, etc.) i.e. "fuel cell mode", or conversely producing fuel on supplying electricity i.e. "electrolysis mode". The key feature of a SOC is the solid ceramic oxide electrolyte which serves as an ion transport medium (oxide ions or protons) and as a membrane between the reducing cathode and oxidizing anode atmospheres. Ceramic electrolytes are key to enabling SOFCs to operate at temperatures up to 1000°C.

For the proposed student job, the focus will be on cells running in "electrolysis mode" with proton-conducting ceramic electrolytes. The objective is to produce NH_3 from N_2 and steam using a SOEC as illustrated in Fig. 1. This is a vanguard research topic with widespread potential and applicability. The standard industrial process for NH_3 synthesis is the widely known "Haber-Bosch" process. However, the process needs very high pressures and a steady supply of H_2 which needs to be synthesized locally. Evidently, since SOECs run at atmospheric pressure and can utilize more freely available reactants like steam to produce NH_3, there is considerable interest in exploring this process. In fact, since 2009, of the three journal publications on the production of NH_3 using steam electrolysis [1–3], two of them have been in Nature and Science respectively [2, 3].

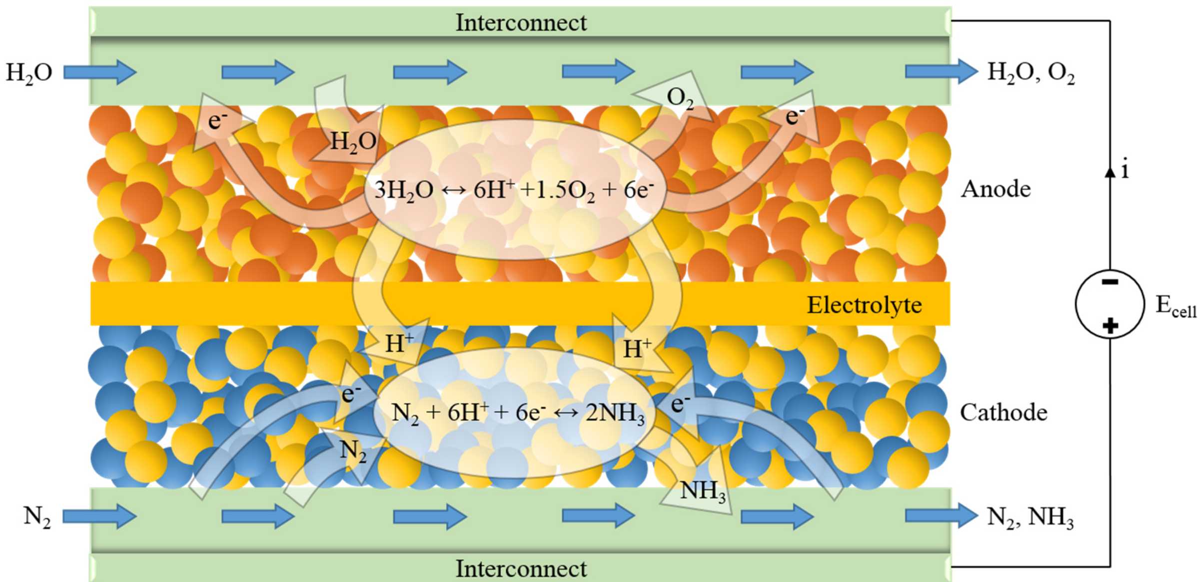

Figure 1: Schematic of a planar proton conducting steam electrolyzer for NH_3 production

The selected student will be intricately involved with the entire experimental process including the preparation, characterization and testing of the electrolysis cells. The student will gain substantial knowledge and experience with micro/nano-scale fabrication techniques like wet sintering, screen printing and infiltration, characterization methods like SEM, TEM and XRD, and measurement techniques like electro-impedance spectroscopy (EIS) and Fourier Transform Infra-Red spectroscopy (FTIR). The high-temperature experimental facility required for the project is located in Geb. 11.21, KIT Campus Süd and is part of a collaboration between KIT and the European Institute for Energy Research (EIFER).

Requirements:

Applicants require a keen interest in experimental work and a strong motivation to work with clean energy devices like solid oxide cells.

Starting date:

The ideal starting date is 01.11.2016 though it can be adjusted. The expected duration of the project is around 8-10 months.

Contact:

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References:

1. A. Skodra and M. Stoukides, *Solid State Ionics,* **180**(23-25), 1332–1336 (2009).
2. R. Lan, J. T. S. Irvine and S. Tao, *Scientific reports,* **3,** 1145 (2013).
3. S. Licht, B. Cui, B. Wang, F.-F. Li, J. Lau and S. Liu, *Science (New York, N.Y.),* **345**(6197), 637–640 (2014).