The main objective of the proposed research is to investigate properties of mixed proton-electron conducting (MPEC) composites. The study of how chemical composition, crystal grain size and porosity of MPEC composites influence the properties of a single layer fuel cell (SLFCs) made of that composite are of particular interest. The results of this investigation will facilitate the verification and development of the proposed working principles of single layer fuel cell operation. Single layer fuel cells are breakthrough electrochemical sources of electrical energy. A comparison of conventional and single layer fuel cells is presented in fig. 1.

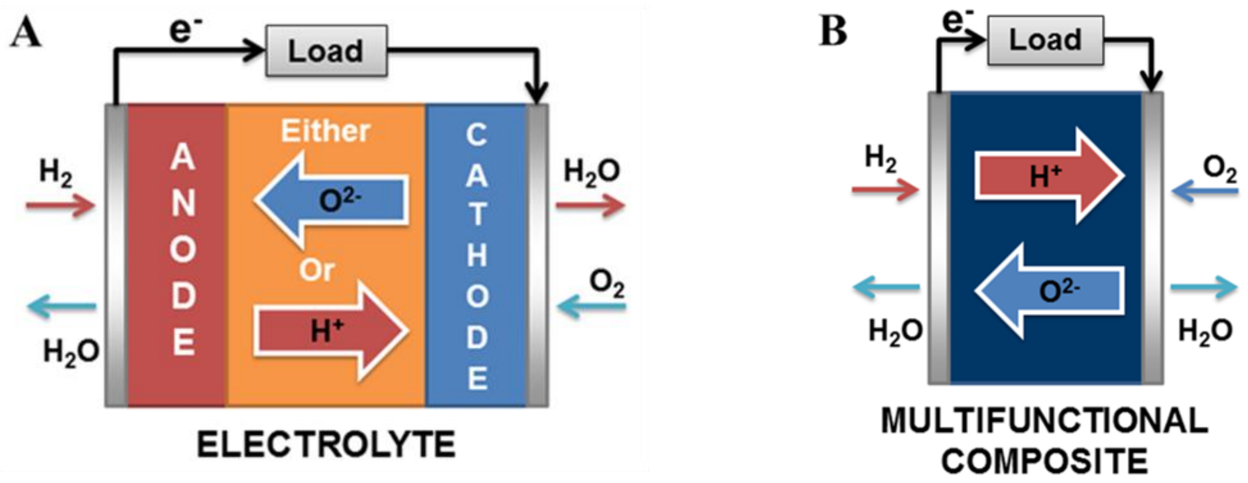

Fig. 1 Comparison of conventional (A) and single layer (B) fuel cells.

In the course of the proposed project, various mixed proton-electron conducting composites will be synthesized. Different proton conducting materials (such as $BaCe_{0.6}Zr_{0.2}Y_{0.2}O_{3-\delta}$, $BaCe_{0.7}Zr_{0.1}Y_{0.1}Yb_{0.1}O_{3-\delta}$, $La_{0.98}Ca_{0.02}NbO_{4-\delta}$) as well as different electron conducting materials (such as the solid solution of Li_2O:NiO:ZnO oxides) will be used to form the composites.

The structure of these materials and composites will be studied by means of X-ray diffractometry. The influence of synthesis conditions on microstructure of the materials will be investigated by scanning electron microcopy. X-ray photoelectron spectroscopy and energy dispersive X-ray spectroscopy will be used to probe the spatial distribution of elements in the synthesized materials and composites.

Electrical properties of composites and single layer fuel cells will be analyzed by means of DC and AC measurements, including measurements in varying temperatures and oxygen partial pressures. Proton diffusion both in composites and single layer fuel cells will be imaged by using tritium as a radiotracer for autoradiography, which will allow the verification of the postulated working principles of the SLFCs.

Studying the transport properties of mixed proton-electron conducting composites will provide a broad spectrum of useful and valuable information about the working principles of these material systems and devices based on them. This information will pave the road for further fundamental and applied research. Eventually, it will become possible to rationally design composite MPEC materials that match the expected properties, dictated by applications in single layer fuel cells and other electrochemical devices.

Due to a relatively simple manufacturing process the costs of their manufacture will be much lower than that of state of the art fuel cells. The resulting more accessible price point will move fuel cells from the niche they currently occupy and thrust them out into the public market for consumers and industry alike. This will finally bring about the long heralded shift from the current hydrocarbon economy to a much greener hydrogen economy. Using hydrogen as the main source of energy will have a huge economic and societal impact due to the increased energy security connected with the general abundance of water as a source of hydrogen as well as due the influence of reduced emissions on the environment and public health.