Strain engineering of proton conducting oxides
SEPCON

The basic properties of materials – electrical, chemical and mechanical – are all interconnected. Shifting one of the properties doesn't go unnoticed and causes a response in the others. In the material science community this has come to be referred to as the "**electro-chemo-mechanical coupling**", depicted schematically in Figure 1a.

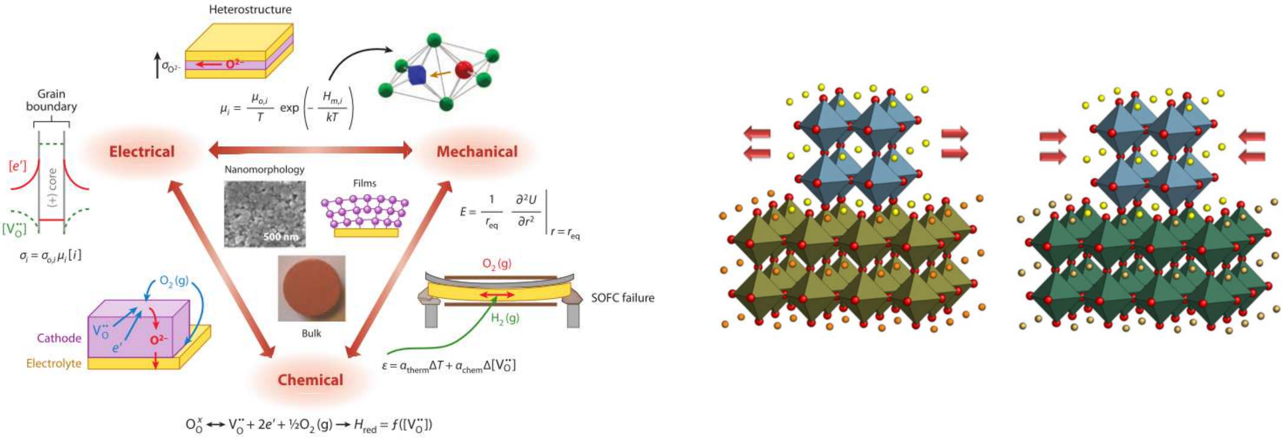

Figure 1 a) Schematic representation of the electro-chemo-mechanical coupling (Tuller, 2011) b) Principle of inducing strain through substrate choice

While the observation that mechanical strain influences electrical conductivity has been made over 160 years ago by Lord Kelvin, the practice of purposefully influencing the electrical and chemical properties of a material by means of mechanical deformation is much more recent. It first began with work on how strain influences the electronic properties of semiconductors back in the 1950s. The practice is now commonly referred to as **strain engineering** and is being applied in commercial semiconductor devices as well as new classes of materials.

Today, strain engineering of ion conducting materials is on the rise, because of their many uses in various electrochemical devices such as fuel cells, electrolysers and sensors. The goal of this project is to investigate the influence of strain on thin films of a promising subtype of ion conducting materials – proton conductors, which so far have not received their deserved attention.

As a part of the project, the following research will be carried out:

I. Deposition of **thin films**, by means of physical vapour deposition (**PVD**).

II. Inducing strain in the deposited proton conducting thin films through:
- choice of support (see Figure 1b),
- choice of the type and parameters of the deposition process
- mismatch in coefficients of thermal expansion between film and substrate,
- chemical methods by using specifically chosen dopants.

III. Characterization of:
- Induced strain, by means of x-ray diffractometry and Raman spectroscopy
- Mechanical properties, using nanoindentometry
- Electrical properties, by DC techniques and electrochemical impedance spectroscopy