With the steady depletion of fossil fuels, concerns over climate change and other environmental issues and the need for secure sources of fuel supply, the need to explore alternative sources of energy is becoming more urgent. This situation presents a fundamental challenge for chemistry and for materials chemistry especially, since not only are means to produce energy and/or fuels sustainably required, but also we will require new materials to store this energy effectively. In addition to the concept of sustainable fuels, one can thus consider storing electrical energy directly (for example in batteries).

Our research at Glasgow is concerned with many of these aspects at the interface of materials chemistry and energy. This talk will consider how one might design and produce new materials that have high ionic conductivity and/or high lithium storage capacity for use as either electrodes or electrolytes in secondary batteries (for energy storage). Non-oxide materials prove to be especially relevant in the context of lithium ion batteries and can offer properties and performance not accessible from perhaps better-known oxide materials.

Two principal non-oxide systems will be considered here. The first is based on the fast lithium ion conductor, lithium nitride and it is demonstrated how both ionic and electronic conduction can be enhanced by substitution of lithium with transition metals (Figure 1). The substituted materials form anodes with capacities up to 3 times greater than that of lithiated graphite, C Li,5

The second system concerns alkali metal (lithium and sodium) borohydrides and in this case ionic conductivity can be improved by many orders of magnitude by substitution on the anion sublattice and/or by simultaneous isovalent substitution on the cation sublattice.6,7

The effects of nanostructuring (Figure 2) can be extremely relevant and important in both of these contexts and how one might employ nano-design strategies in developing new sustainable energy materials will be discussed.

7. I. Cascallana; E. J. Cussen; D. H Gregory In preparation.

Figure 1. (a) Structure of Li,N; (b) Structure of LiNiN

Figure 2. SEM micrograph of nanofibres of Li,N