2022_44_ESE_Hadler: Transforming mine waste into a raw material for sustainable battery production

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In the transition to zero pollution, batteries are a critical enabling technology. The global electrification of vehicles requires large amounts of lithium, natural graphite, nickel and cobalt to manufacture sufficient rechargeable batteries. The battery materials supply chain is crucial for diversification of batteries and their widespread deployment to cope with energy demands. This need is driving the search for new material sources processing raw materials, and new recycling methods for material reclamation. Graphite, for example, is mined as a raw material for Li-ion battery anodes, however the long-term environmental damage and regional dependency caused by this is often overlooked.

Iron disulphide particles have received increasing attention as battery materials in recent years due to their low cost, relative abundance, and high theoretical capacities. New battery technologies based on sodium-ion and lithium-sulphur chemistries are expected to provide a step-change in energy storage in the near-future. Iron disulphide, or pyrite, is critical in these new technologies. Natural pyrite has been shown to be as effective as synthesized FeS2 in battery performance.

Pyrite is available at large scale in mine tailings, both freshly produced and in tailings ponds. The weathering of pyrite is a cause of acid mine drainage; a process that has caused significant environmental damage in legacy mines, and that requires environmental controls in operating mines. The removal of pyrite from tailings streams prior to deposition in tailings ponds has been implemented as a way of reducing the impact of pyrite-bearing tailings. Recovering and using this waste as a raw material in battery production, however, will transform waste pyrite from a hazardous valueless mineral into a sustainable source of battery raw materials.

This PhD project will investigate the potential for the transformation of tailings pyrite into raw materials for batteries. This will build on a proof-of-concept study, in which a functioning battery was produced from tailings pyrite. Although the concept has been demonstrated, there remain many questions, particularly around the characteristics of pyrite from tailings and their effect on battery performance. The project will study pyrite-bearing waste from multiple sites (e.g. Spain/Portugal) and at different ages (fresh tailings and from tailings ponds). The aim is to establish the variability of the pyrite from a given location, the processes required for cleaning the pyrite to an acceptable purity, and the limits of that purity with respect to battery performance. These aspects are underpinned by an understanding of the mineralogy of the ore and this will be used to identify suitable locations for future implementation. The research will consider the environmental impact of recovering pyrite from tailings at industrial scale, through modelling and simulation.

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