How is it that SMD Cells do what they do!

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Part 2.

Moving on from part 1, to possibly an even more exotic explination of what goes on in the SMD cell, other facts known have to be taken into consideration.

Iron oxide is infact a poor conductor, depending on the type and the environment in which it finds itself. The two most common oxides are hematite and magnetite, they are both semi conductors and are both found in SMD cells which use iron as the reaction electrode. Within the oxygen and hydrogen environment electrons are now known to hop from one atom to another, this has been shown by experiment in the following quotes:-

Despite this poor conductivity, an electron transferred to a particle of rust will use thermal energy to continually move or “hop” from one atom of iron to the next. Electron mobility in iron oxide can hold huge significance for a broad range of environment- and energy-related reactions

“Using ultrafast pump-probe X-ray spectroscopy, we were able to measure the rates at which electrons are transported through spontaneous iron-to-iron hops in redox-active iron oxides. Our results showed that the rates depend on the structure of the iron oxide and confirmed that certain aspects of the current model of electron hopping in iron oxides are correct.”

With time-resolved pump-probe spectroscopy system in combination with *ab initio* calculations performed at the Pacific Northwest National Laboratory, colleagues determined that the rates at which electrons hop from one iron atom to the next in an iron oxide varies from a single hop per nanosecond to five hops per nanosecond, depending on the structure of the iron oxide. Their observations were consistent with the established model for describing electron behavior in materials such as iron oxides. In this model, electrons introduced into an iron oxide couple with phonons (vibrations of the atoms in a crystal lattice) to distort the lattice structure and create small energy wells or divots known as polarons.

“These electron small polarons effectively form a localized lower-valence metal site, and conduction occurs through thermally-activated electron hopping from one metal site to the next”.

This all holds well with what has been seen with SMD, and probably explains why the hydrogen only electrode continues to provide prolific amounts of hydrogen when the positive electrode is producing semi conducting oxides. An explination as to what happens when the positive electrode becomes negative on changeover, maybe that mainly hematite is produced when positive and after when negative (hydrogen gas) the hematite is reduced to magnetite. $3Fe_2O_3 + H_2 \rightarrow 2Fe_3O_4 + H_2O$. Fe3O4, magnetite is an electrical conductor with a conductivity significantly higher (X 106) than hematite, Fe2O3, and this is ascribed to electron exchange between the FeII and FeIII centres.

So in the end what do we have, that not only produces hydrogen, but also generates electricity, it is infact a slant on a solid oxide fuel cell, SOFC, where we oxidise a fuel, in this case iron. It is intended to continue research into the possibilities of building a new type of fuel cell, where the hydrogen produced is also used to produce power in a secondary part of the cell, as opposed to pure cheap hydrogen being the final product. The future should be interesting.