Introduction to Gas Loading

The introduction of protons or deuterons into solids can be done from the gas phase, as an alternative to electrochemical loading from a liquid phase. This approach to loading has been pursued since the early days of the experimental study of low energy nuclear reactions. The characteristics and results of gas loading are the subjects of this section.

The energetics of gas loading can be favorable. With electrochemical loading, power has to be continuously applied to a cell, often for long periods (days and weeks) to initiate and, in general, to sustain LENR. In the case of gas loading, the only power that might have to be applied is to pressurize the hydrogen or deuterium gas that is in contact with the solid to be loaded. If the solid consists of small particles, loading happens rapidly without necessarily having to provide additional electrical power. If high temperatures are needed, power must be applied, at least to start continuing and self-heating reactions. By contrast, the production and maintenance of either plasmas or beams for loading by use of energetic particles is energy intensive. The production of plasmas requires both ionization and relatively high particle kinetic energies. Similarly, the generation of ions for beams takes energy, as does their acceleration for implantation into solids.

Practical systems that might emerge would be relatively simple if they are based on gas loading. Electrochemical systems have complexity similar to fuel cells, which are actually electrochemical systems. In such systems, there has to be a tightly integrated assembly of chemical, electrical, thermal and fluidic capabilities. The engineering of LENR electrochemical systems for consumer use is certainly possible. Batteries provide a paradigm for such systems. In fact, rechargeable nickel metal and hydrogen batteries are essentially the reverse of LENR electrochemical cells. In the batteries, a current is produced by deloading of hydrogen from the nickel, the reverse of what happens in an LENR experiment. However, commercial LENR energy sources are likely to be more complex than batteries, more like fuel cells, at least in the early stages of commercialization.

There are three papers in this section. The first is a commissioned review of gas loading by Biberian. It provides comparisons of the strengths and weaknesses of both electochemical and gas loading. The following two lists from Biberian are useful –

There are definite advantages to gas loading:

- Pressures are easily controlled.
- It is possible to maintain clean environments.
- Operational temperatures can be high.
- It is easier to measure helium and charged particles.
- There is more potential for practical applications.

There are also some disadvantages:

- It is difficult to achieve very high pressures.

- To do good calorimetry requires more expensive equipment with this technique than with electrolysis.

A comprehensive set of 158 references on gas loading is provided by Biberian.

The last two papers in this section involve the use of nanoparticles, both inspired by the results reported by Arata and both conducted in deuterium atmospheres. Celani and his colleagues used electromigration in a long and thin wire of Pd coated with Pd nanoparticles. The wire was in deuterium gas at pressures of 1.2 to 5.2 atmospheres. One amp direct current was used to drive the deuterons in the Pd wire to the cathodic end of the wire. Excess power of 5.2 W was reported, which corresponds to 370 W/ gm Pd.

Nohmi and his colleagues reported the first results from a new university-industry collaboration in Japan. They did preliminary gas phase experiments with both deuterium and hydrogen in very similar chambers operated in parallel. Powders of Si, Pd and Pd black were placed in the two chambers. With the Pd black, the deuterium cell produced 8.3 +/-4.5 kJ, about a factor of two greater than the blank run of 4.0 kJ.

It is expected that interest in gas loading experiments will continue to grow as LENR near commercialization. It is likely that the first LENR-based products will employ gas loading. Small cartridges, such as those used for containment of carbon dioxide, might be used to provide either hydrogen or deuterium gas at elevated pressures. If initiation of LENR requires elevated temperatures, batteries might be used. In principle, they could be recharged by use of thermoelectric devices that capture energy from waste heat in LENR power systems. In short, both the engineering and operation of LENR energy sources based on gas loading might be simpler compared to electrochemical systems.