reliability. It means that if one cell fails completely the others are able to increase their proportion of current and an entire stack can remain in operation. It was also observed for sulphuryl chloride electrolyte during open circuit phases that reverse currents were passing between cells (when diodes were not used). This did not appear to be detrimental, and no lithium dendrites were observed (we generally do not observe lithium dendrite formation with our electrolyte, a study of dendrite formation will be reported at a later date). Only sulphuryl chloride can tolerate this, recharging being theoretically possible.

In conclusion, it is considered that the "parallel before series" arrangement, whilst maintaining the simplicity of pile type construction, appears to have an advantage over "series before parallel", not only because of lower heat output, but also because the burden of poorly functioning cells may successfully be taken by other cells without the overall performance of an entire stack being compromised.



## P16

### Fuel cells for vehicular applications — hydrogen storage and simulation aspects

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This work has been carried out by an industrial and research laboratory consortium and is now supported by an EU contract. State-of-the-art solid polymer fuel cell (SPFC) technology shows two main difficulties with this power source: On-board hydrogen storage and taking into account all the parameters which affect the global efficiency.

For the first point the technologies of hydrogen storage are reviewed here, including gaseous, liquid, hydride, adsorption or glass microsphere systems. For each technology, advantages, disadvantages, efficiency are presented in term of optimal applications (ship, plane, automobile...). From this review, gaseous technology has been selected and we report about the most promising compromise ($H_2$ pressure to use, materials for tanks, manufacturing technology) for a short term development. A carbon composite/coiled wire tank has been designed for a 70 MPa pressure of use.

First tests show that the main problems are the liner and the end piping.

The second major problem in designing a fuel cell stack concerns the interaction between the current density, the cell's voltage, the output voltage, the heat transfer system, the management of water, the oxygen feed... Computing tools have been successfully developed to simulate the operation of an elementary cell and allow for instance a satisfactory correlation between calculation and experimentation on Nafion® membrane.

## P17

### High performance membrane electrode assemblies for solid polymer fuel cells

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Solid polymer electrolyte fuel cell performance is restricted by factors associated with membrane, electrode and hardware components. We have extensively evaluated a number of Membrane Electrode Assemblies (MEAs) and applied the resulting data to optimise the overall power capabilities. We show how electrodes with a low platinum loading (0.35 mg $cm^{-2}$) can provide comparable performance with electrodes containing a much greater quantity of the electrocatalyst. The key factors governing this high platinum utilisation involve efficient employment of the three dimensional reaction zone, to avoid using superfluous material and to limit problems associated with mass transport.

## P18

### Activity and stability tests in phosphotungstic acid electrolyte fuel cell

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A 40 $cm^2$ cell based on phosphotungstic acid (PWA) electrolyte has been constructed and tested at the Institute CNR-TAE, Messina. The cell works at room temperature, fed with hydrogen and oxygen as reactant gases. A through-flow design has been used in order to avoid excessive dilution of the electrolyte with water produced in electrochemical reaction. The influence of the hydrophobic-hydrophilic characteristics of different electrodes on the activity and stability of the cell has been investigated. Pairs of gas diffusion electrodes (cathode and anode), each having the same composition of diffusional and catalytic layer, with 0.50 mg Pt $cm^{-2}$ have been prepared.

The pairs differed among themselves by the PTFE loading in the catalyst layer. Each pair of electrodes was tested in the monocell for at least 70 hours under cycling conditions and at current density of 400 mA $cm^{-2}$. The monocell tests were conducted with the reagent gases at atmospheric pressure and without external heating. The results of the experiments dem-