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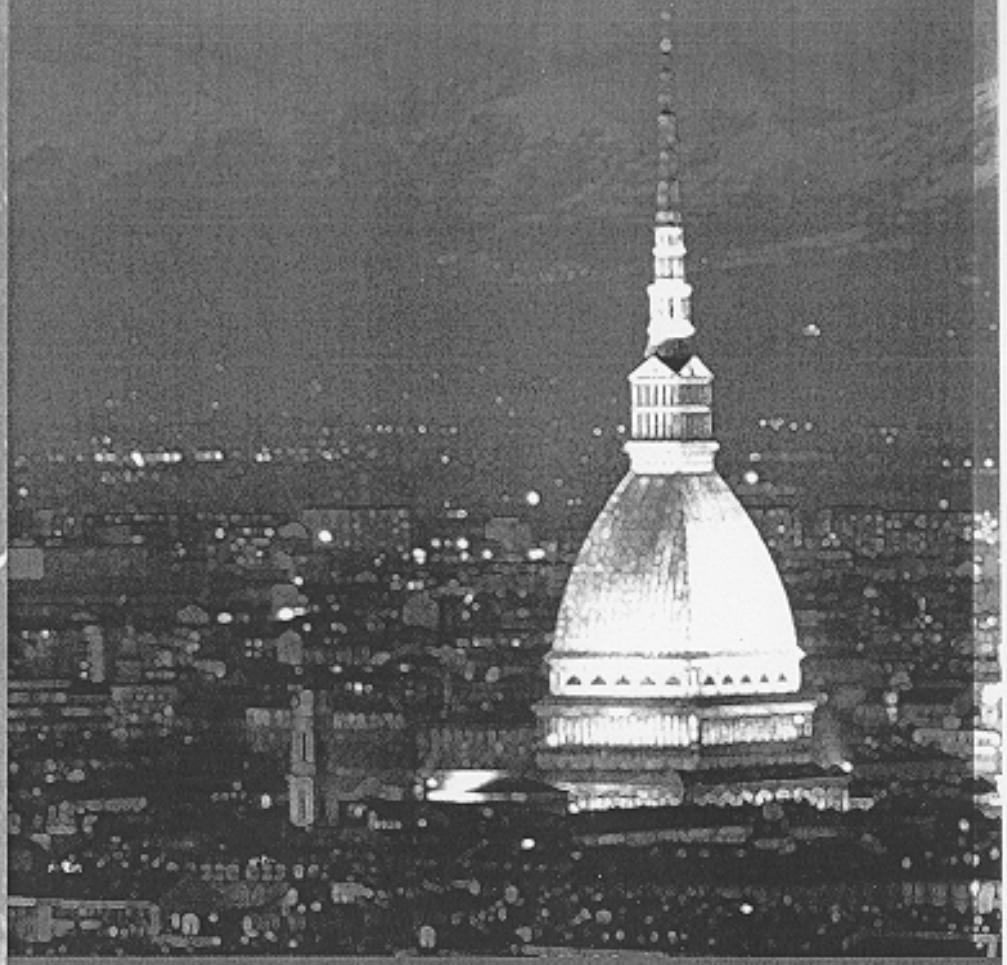

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Surface conductivity and stability of metallic bipolar plate materials for PEMFC

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Polymer electrolyte membrane fuel cells (PEMFCs) are devices that convert the chemical energy of a fuel directly into electrical energy and thus are very promising as an energy source thanks to their high power density performance at low temperature (70-90°C). The bipolar plates are a multifunctional component in PEMFC stack as they collect and conduct current from cell-to-cell, they separate the gases, and the flow channels in the plates deliver the reacting gases to the fuel cell electrodes. The most widely used bipolar plate material is graphite due to its corrosion resistance and conductivity, but its high cost, brittleness and lack of mechanical strength limit this material for applications involving high-volume manufacturing. Metals can also be used to make bipolar plates due to their very good heat and electricity conductor characteristics, but they are prone to corrosion. Due to these problems, alternative materials suitable for use in fuel cell technology and able to achieve long lifetime are a key issue in this research field. A possible solution is the use of materials as stainless steel (SS) to overcome the disadvantage of insufficient corrosion resistance in chloride or oxidizing acid solutions. Another approach can be the use of the physical vapor deposition (PVD) method to coat metal bipolar plates and to lower the contact resistance. Besides, Ni-based alloys, though vastly used in process industry and in energy production for nuclear power plants, so far have not been investigated for use as bipolar plates in PEMFCs.

This work aimed at investigating the interfacial contact resistance (ICR) of three groups of alloyed materials: a) common stainless steels (304, 310S, 316L and 904L), b) Ni-based alloys (Hastelloy® C-2000®, G-30®, C-22® and C-276®) and c) PVD-coated SS304 with six different types of nitride layers.

Results show that common stainless steels demonstrated to be unsuitable for use as bipolar plates because of the presence of too large amount of non-conductive oxide (e.g. [Fe+Cr] > 69% and Ni < 24%) that leads to high ICR values. For both common and Ni-based stainless steels, the decrease of [Fe+Cr] content and their non-conductive oxides seems to be the relevant aspect for a diminution of ICR. In addition, all the Ni-based alloys have an ICR value lower than that of BMA5 graphite, and particularly, that of C-276® is also lower than that of commercially available best XM9612 graphite. Our best nitride-coated stainless steel specimen presented a lower ICR value with respect to that of the best uncoated 904L stainless steel. In addition, endurance tests in cathode and anode environments gave very promising results.

The PVD method showed to be an interesting alternative for bipolar plate manufacturing. Further studies are being performed in order to analyze the optimal composition and thickness for our best nitride-coated stainless steel specimen and long-term stability tests in a single fuel cell.

Keywords: Bipolar Plate, Coatings, PEMFC, Fuel Cell