

In recent times, on board reforming of hydrocarbons to fuel PEMFC stacks in vehicular applications has fallen from favour, in part due to the complexity and cost of the CO clean up system required. Current Pt or PtRu PEMFC anode technology operates using ppmCO levels, whilst the output from the reformer contains ~2% CO, so multiple CO clean up reactors are required, adding cost and complexity to the overall system.

Recent work at Johnson Matthey has highlighted the possibility of a new approach to the problems of CO clean up system complexity¹. A series of PtMo materials have been prepared and studied, which show tolerance to high CO levels (up to 5000ppmCO) without the use of an air bleed. Use of these materials in the anode would allow a PEMFC stack to operate using the output from a reformer and single Water Gas Shift reactor; a significant simplification of the CO clean up system. At high CO levels stack performance (and efficiency) will be reduced by anode CO poisoning, compared to current low CO tolerant strategies, but this can be offset by reduced overall system size and cost. The ideal target application for this technology might be an Auxiliary Power Unit for a diesel or gasoline engine.

PtMo materials were incorporated into PtMo/PtRu bilayer anodes² and their high CO reformate performance compared to single layers of PtMo and PtRuMo ternary catalysts, and a mixed layer of the PtMo and PtRu catalysts (Fig 1). The data demonstrate two distinct layers are required, as a simple mixing of the two catalysts (PtMo and PtRu) in a single layer is inferior to the PtMo/PtRu bilayer. The PtMo/PtRu bilayer gave optimum high CO reformate performance, and is clearly better than the ternary PtRuMo materials. In our study, PtRuMo ternary materials were observed to be less active than a mixed layer, so addition of Mo to a PtRu material does not promote the CO oxidation mechanism.

Performance and CO conversion properties of the PtMo and PtMo/PtRu bilayer anodes were investigated using simulated reformates containing 2000 and 5000ppmCO, based on a reformer and single WGS reactor. At current densities > 0.5A/cm² CO conversions in excess of 95% were observed, although conversion fell to zero on reducing current to zero (OCV) (Fig 2). Measurements of CO and CO₂ content in the anode PEMFC exhaust were used to determine CO conversion values. A higher anode overpotential (at a given current) in the 5000ppmCO reformate produces slightly greater CO conversion when compared to 2000ppmCO. The low CO conversions at low anode overpotential (close to OCV) demonstrate the CO removal reaction on these catalysts is electrochemically driven.

The overall efficiency of a simplified fuel processor and a

fuel cell containing the PtMo/PtRu bilayer anode technology will be compared to a conventional fuel cell system with fuel processor, multi-stage CO clean up reactors and a conventional PtRu anode.

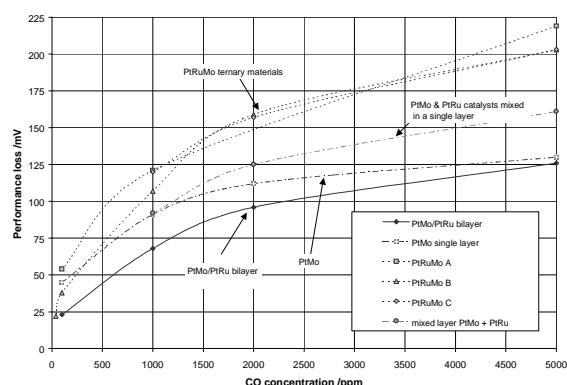


Figure 1 Performance losses for PtMo and PtRu anodes on high CO reformate.

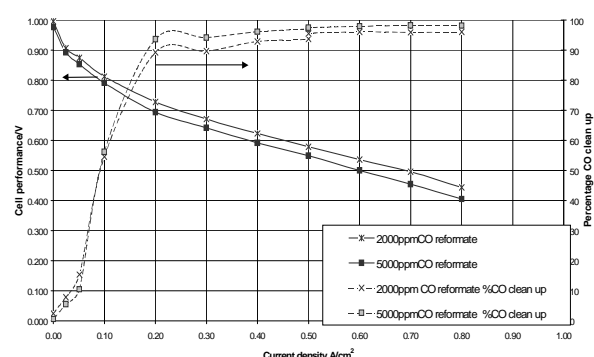


Figure 2. Plot of Polarisation performance and %CO conversion for PtMo/PtRu bilayer anode using 2000 ppm and 5000ppmCO reformate

¹ Investigation of PEMFC MEAs for Ultra-High CO Reformate, S Ball, ETSU F/02/00261/00/00 2004

² EPA 838 872 and EP 1 115 465 B1