STABILITY OF PLATINUM NANOPARTICLES IN FUEL CELLS

Electronics

Effect of solvent polarity

INTRODUCTION

Fuel cells have been extensively studied during these last decades as they appear as environmentally friendly power sources. They convert the chemicals hydrogen and oxygen into water and electricity, *via* a reaction between fuel (on the anode side) and an oxidant (on the cathode side) in the presence of an electrolyte. The reactants flow into the cell, and the reaction products flow out of it, while the electrolyte remains within it. Fuel cells can operate virtually continuously as long as the necessary flows are maintained.

Platinum is typically used as a catalyst to facilitate the chemical reaction in polymer exchange membrane fuel cells (PEMFC). It consists of a dispersion of nanoparticles.

METHOD

In this work, we present three formulations of platinum nanoparticles: formulation 1 consists of 50 nm Pt nanoparticles in water; formulation 2 contains 50 nm Pt particles dispersed in isopropanol (IPA); and finally formulation 3 corresponds to 100 nm Pt/Ru (1:1 wt%) nanoparticles dispersed in IPA. All these products are black colored samples, which have been studied in the Turbiscan LAB at ambient temperature for 5 hours.

RESULTS

Platinum nanoparticles in water

Formulation 1 displays no variation of transmission or backscattering over the 5 hours of analysis (Figure 1), hence proves to be highly stable.

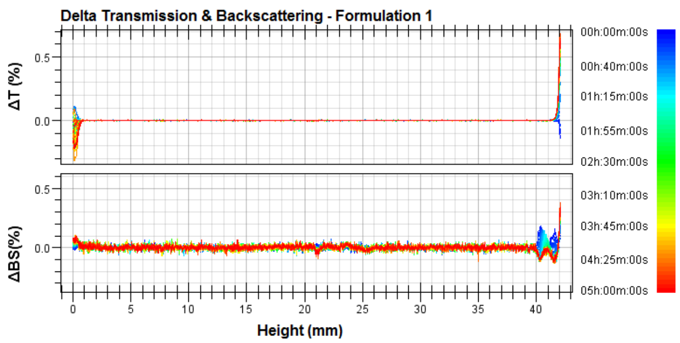

Figure 1: Delta-transmission (top) and backscattering (bottom) for formulation 1 at 25°C.

Platinum nanoparticles in IPA

Formulation 2, on the other hand, is undergoing large sedimentation (Figure 2), with an important increase of the transmission signal towards the top of the sample.

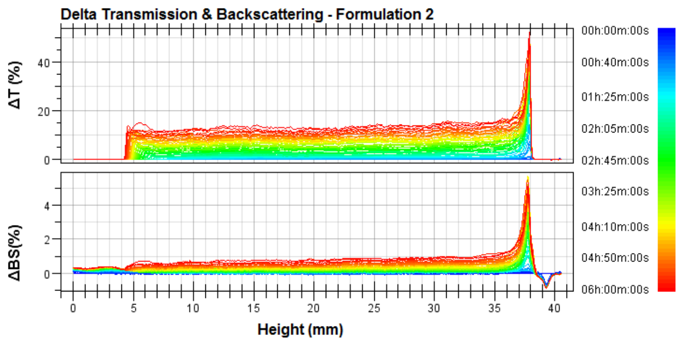

Figure 2: Delta-transmission (top) and backscattering (bottom) for formulation 2 at 25°C.

It is important to note that when transmission signal is greater than 0.2%, backscattering signal should be overlooked as it is affected by secondary reflections on the glass. Therefore, in this example backscattering should only be considered in the bottom part (from 0 to 6.5mm).

Platinum/Ruthenium nanoparticle mixture in IPA

Formulation 3 consists of a mixture of platinum (Pt) and ruthenium (Ru) nanoparticles dispersed in IPA. Figure 3 shows that no transmission is displayed over the duration of analysis, hence no major clarification. The variation of backscattering shows an increase of the backscattering at the bottom, as the particle concentration increases due to sedimentation. At the top, a slight decrease of backscattering is seen as clarification takes place. The middle part is more peculiar, as it displays a progressive increase of the backscattering towards the bottom of the sample. This is due to the coupling of aggregation and clarification of one of nanoparticles type, when the other type simply settles. As the nanoparticles aggregate, backscattering increases and this is emphasized by sedimentation.

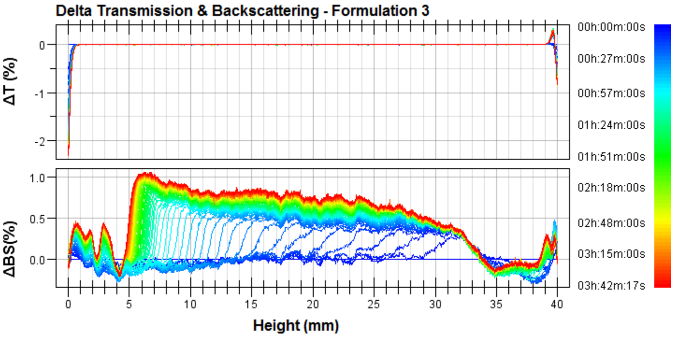

Figure 3: Delta-transmission (top) and backscattering (bottom) for formulation 3 at 25°C.

The two populations of platinum and ruthenium nanoparticles would therefore exhibit a different behaviour. It is likely that platinum is showing only sedimentation, when looking at data from the two other formulations. Therefore the middle part would be due to the aggregation and sedimentation of ruthenium nanoparticles.

SUMMARY

The Turbiscan LAB enables to determine the instability mechanism and compare the stability of various formulations dedicated to fuel cells. The polarity of the solvent is showing a major role in this case, in the stabilisation of the nanoparticles.