Topic: Hydrogen Sensors

IMCS25_332 - Flexible and thin Top-Bottom-Electrode Hydrogen Sensors for Aerospace and Battery Applications

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Flexible and thin Top-Bottom-Electrode Hydrogen Sensors for Aerospace and Battery Applications

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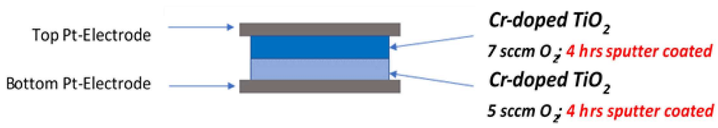
Summary

Hydrogen (H_2) is undoubtedly the most popular future green energy carrier due to its harmless by-product, water. Thus, hydrogen becomes the most attractive energy carrier for light-weight and high safety requiring applications such as aerospace and power storage. However, as far as storage and transport of hydrogen in mobile applications are concerned, still the precautions must be taken, because H_2 is colourless and odourless but flammable in air with very low ignition energy and combusts in air [1]. The so-called Top-Bottom-Electrodes (TBE) combined with TiO_2 sensing layer [Pt/TiO_2/Pt] utilising Memristor sensor principle. Pt results in reduced Pt/TiO_2 Schottky interface [2].

Content

By Memristor sensors, the sensing mechanism is primarily justified with the variations in Schottky Barrier Height at the Pt/TiO_2 and TiO_2/Pt interfaces. Moreover, it is proven that in terms of hydrogen sensing, Pt acts as a catalyst to dissociate hydrogen molecules that can migrate quickly to the TiO_2 surface and further diffuse into the bulk. Relying on this fact, the Cr-doped TiO_2 sensing layer is fabricated in two different stochiometric relations by means of reactive sputtering as sandwiched between the top and bottom Pt-electrodes. The bottom side of the sensing layers deposited by inducing 5 sscm O_2 while top-side with 7 sccm O_2, each for 4h (Fig. 1). Thus, the Schottky barrier height at TBE interfaces differs. To enable flexibility, the sensor fabrication is carried on polyimide (PI) foils.



(a)

Figure 1: Schematic of Top-Bottom-Electrode sensor configuration fabricated Cr-doped TiO_2 sensing layers

The gas sensing tests of Pt/TiO_2/Pt structured sensors were performed with a computer-controlled experimental setup (sensor and catalyst characterization unit - SESAM) at DLR Cologne. The sensing measurement tests towards 600-2000 ppm H_2 are carried in synthetic air and in argon carrier gas at temperatures varying RT, 40°C and 60°C under the bottom electrode bias conditions. At RT and in Argon, the sensor shows a moderate response displayed with significant drop in resistance on hydrogen release whereas remains very poor in synthetic air. At 40° C, under both carrier gas environment, the sensitivity increases due to enhanced interaction between hydrogen molecule and the sensing surface and baseline stability improves. Significant baseline resistance drift has been eliminated by heat-treatment of the whole sensor at 100°C wielding better sensor property. The baseline resistance of the sensor is unstable at 60° C however sensitivity improves further.

References

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