Dye-sensitized solar cell using tungsten electrode on ceramic substrate

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Introduction

Dye-Sensitized Solar Cell (DSSC) was reported in *Nature* [1] by Prof. Grätzel of Swiss Federal Institute of Technology at Lausanne in 1991, since then the subject has been actively studied by many researchers because of the economy of manufacturing process, and less environmental hazard.

The typical structure of DSSC is that two transparent conductive oxide (TCO) glasses are laminated face to face. Dye-sensitized nano-TiO_2 electrode is formed on one TCO glass one side, and Pt catalyst is formed on another side of glass; between the two sides of glasses I_3^-/I^- redox electrolyte is filled. Since electrical resistance of TCO glass is not so low, collecting grids are needed in case of a large-size cell. Since the redox electrolyte is very corrosive the conventional collecting grids (Cu, Ag, etc.) cannot survive during prolonged durability test even if some sort of protective coated on the surface.

It is believed that high melting point metals, such as tungsten should have good tolerance against the redox electrolyte, we applied tungsten printing and co-fired technology on ceramic substrate, the technique is common for our ceramic IC packages fabrication to DSSC.

Experimental

The current density-voltage (J-V) characteristics of Pt catalytic electrode and various metals (W, Ti, Ta, Mo, Ni, Nb) were measured by cyclic voltammetry to evaluate corrosion-resistance. The electrolyte is consisted of 0.1M Lil, 0.05M I_2, and 0.6M 1,2-dimethyl-3-propylimidazolium iodide in butyronitrile. The result showed that Tungsten had lowest current flow in tested materials indicating that it is best metal material as grids among other materials.

Also the same corrosion-resistant tests were performed using actual co-fired Tungsten electrode on ceramic substrates. The J-V characteristics were shown in Fig. 1. It is confirmed that tungsten has better corrosion resistance than TCO, which has been used for typical DSSC.

The sheet resistance of tungsten counter electrode on ceramic substrate is $17 \times 10^{-3}\,\Omega$/square which is far less than that of $10\,\Omega$/square of TCO.

Tungsten grid also can be applied on nano-TiO_2 formed glass working electrode by wiring or sputtering, which further contributes to effective electron collection.

Fabrication of DSSC comprised 8 cells connected in parallel with ceramics substrate is shown in Fig. 2. The detail will be presented at the conference.

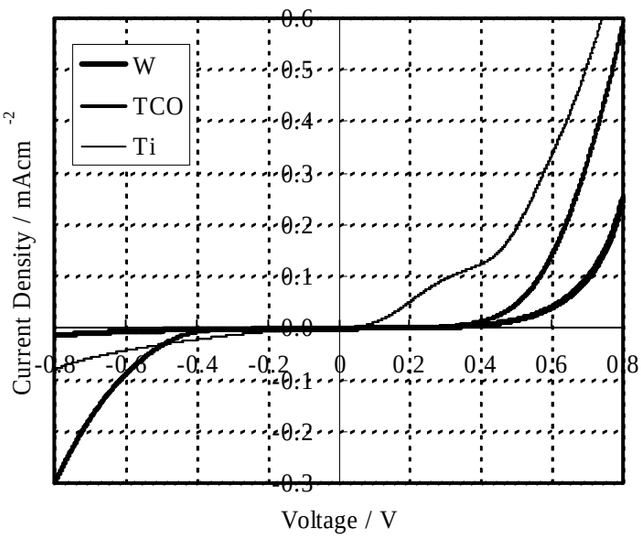

Fig. 1 The J-V characteristics of Pt catalytic electrode and W, Ti, and TCO were measured by cyclic voltammetry.

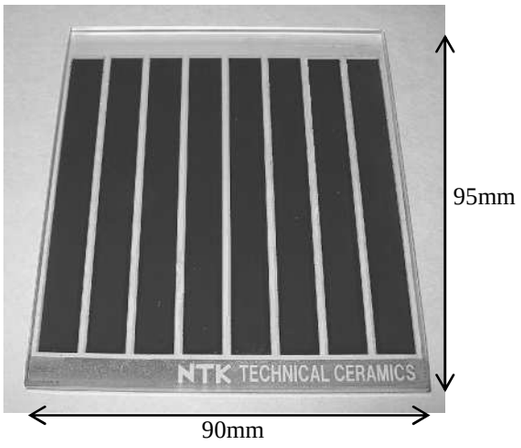

Fig. 2 Photograph of DSSC using ceramic substrate

References

1) B. O'Regan and M. Grätzel, Nature 353 (1991) 737