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CONCLUSIONS

General summary:

DSSCs were fabricated successfully, and results were cross checked multiple times. Fabrication steps were explained in detail. Dye desorption challenge, Shor-circuiting of device, peeling of layers at anode and dye degradation issue due moisture intake, were addressed successfully in this work. Other challenges such as high cost of platinum cathode material was addressed using graphene synthesized samples. Leakage of liquid electrolyte is addressed by developing biodegradable gel electrolyte and incorporating it in DSSC. In this work, DSSC with maximum 3.2 % efficiency is fabricated which is lower than highest reported efficiency of DSSC i.e. ≈ 14%. As this work is focused on optimizing DSSC performance, so that it can be used as in place of glass in buildings and cars. Also, DSSC can be used as tendom DSSC with silicon solar cell.

- **Optimization of dye sensitized solar cell fabrication steps and addressing dye desorption challenge**

- DSSC with 3.2 % efficiency is fabricated and reproduced many times.

- The spin coating technique is successfully employed for coating compact, transparent and reflective layer to obtain uniform coating.

- 3 no. of transparent layer with ~6 μm thickness is optimum thickness of dye adsorbing layer.

- AFM images of compact layer showed cracks, which are main reason of short circuiting in the cell, therefore both pre and post coat of compact layer is needed.

- The thickness of compact layer and reflective layer for optimum efficiencyis around 500 nm and 4 micrometers, respectively.

- Dye desorption challenge is successfully addressed with adding dye inelectrolyte with 0.36 mg/ml optimum conc.

- Standard DSSC is fabricated with 3.2 % efficiency, 8.2 mA/cm^2 Jsc, 0.63 V Voc and 0.62 FF.

- The thickness of compact layer, transparent layer & reflective layer are ~500nm, ~ 6 μm and ~ 4 μm.
- Maximum power density of DSSC with 3.2 % efficiency is 3.2 mW/cm^2 at 0.49 V.

- **Synthesis of graphene and its application in DSSC**

- Types of graphene sample namely S1, S2, S3, S4 and S5 are

synthesized by liquid exfoliation, oxidation-reduction route and combined synthesis route.

- Exfoliation plays an important role improving quality of graphene in terms of C/O ratio, no. of layers, d-spacing, band gap and charge transfer resistance.
- DSSC fabricated using counter electrode made from S4 graphene solution gave efficiency of 3.4 %, which is higher than efficiency of Pt counter electrode DSSC.
- Most conductive S4 graphene is added to liquid electrolyte in optimum conc. of 2.5 mg/ml.
- DSSC fabricated using graphene liquid electrolyte gave 3.7% efficiency, which is higher than efficiency i.e 3.2 % of standard DSSC.

▪ **Development of gel electrolyte and its application in DSSC**

- Both aqueous and non-aqueous gel electrolytes are developed using plant based and biodegradable agar-agar.
- Dye is added to gel electrolyte to stop dye desorption in DSSC.
- Graphene is added in dye+gel electrolyte to improve conductivity of gel electrolyte.

- Conductivity of non-Aq+Graphene gel electrolyte is 3.6 mS/cm^{-1}, which is higher than conductivity of aq. and not modified non-aq. gel electrolytes.
- Efficiency of DSSC fabricated using aq. Gel electrolyte drops from 3.2 % to 0.3% due to dye degradation.
- Efficiency of gel DSSC is improved to 1.1 % to 1.7 % by adding dye gel electrolyte.
- Efficiency of gel DSSC is improved to 2.4 % by adding graphene to dye+gel electrolyte.

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FUTURE WORK

- In optimization study, effect of thickness of reflective layer and compact layer can be studied.
- Dye desorption challenge can be addressed by using co-adsorbent as dye is expensive chemical, both studies can be compared.
- Other coating methods like screen printing and dip coating methods can be explored.
- Natural plant extract can be used as sensitizer to reduce cost of DSSC.
- Anode material modification study can be done to further improve efficiency of DSSC.
- As only material modification study is presented, design modification studies can be done.
- Study of Tendom DSSC with silicon solar cell can be done, which is promising future of solar cell.