CHAPTER-6

PERFORMANCE ANALYSIS OF GEL DSSC

This chapter discusses preparation of gel electrolyte using agar- agar material. Fabrication of DSSC using plant-based gel electrolyte is shown. Dye desorption issue is discussed. At last, addition of graphene into gel electrolyte to increase its ion mobility and conductivity is also discussed in this chapter.

6.1 Aqueous gel preparation

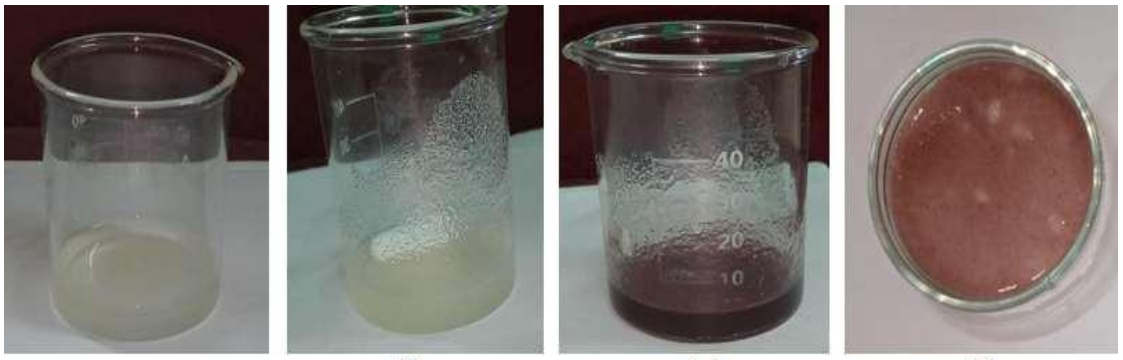

Fig.45: Preparation of aq. gel electrolyte: Agar-agar in distilled water (a) undissolved, (b) dissolved, (c) agar solution and liquid electrolyte, and (d) Aqueous Agar-agar gel in Petri dish

Aqueous gel electrolyte with agar-agar is prepared and is shown in Fig. 44. Aqueous gel electrolyte is incorporated in DSSC cell assembly. Refer chapter 3, section 3.3.1.2 for cell fabrication and section 3.3.3.1 for preparation of aqueous gel.

6.2 Non-Aqueous gel preparation and its modification

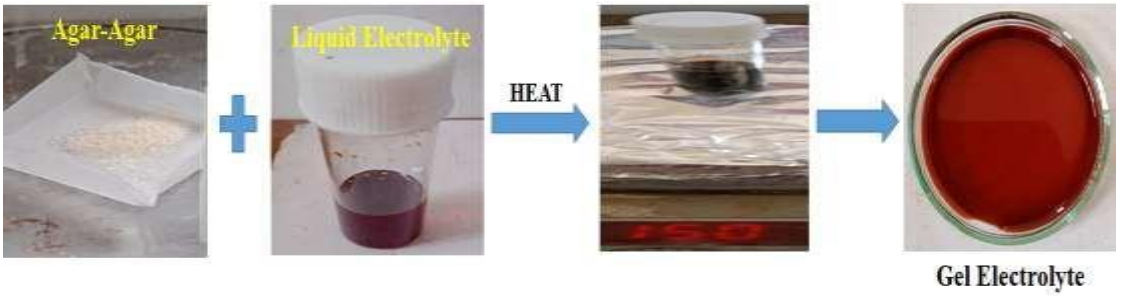

Fig.46: Preparation of non-aqueous gel electrolyte using agar-agar

Non-Aqueous gel electrolyte is prepared, and modifications are done in non-aqueous gel electrolyte. Refer chapter Refer chapter 3, section 3.3.3.2, 3.3.3.3 and 3.3.3.4 for non-aqueous gel electrolyte preparation and its modifications. Non-aqueous gel electrolytes are incorporated in DSSC cell assembly and cells are tested. Refer chapter 3, section 3.3.1.2.

6.3 Conductivity of Different Gel Electrolytes

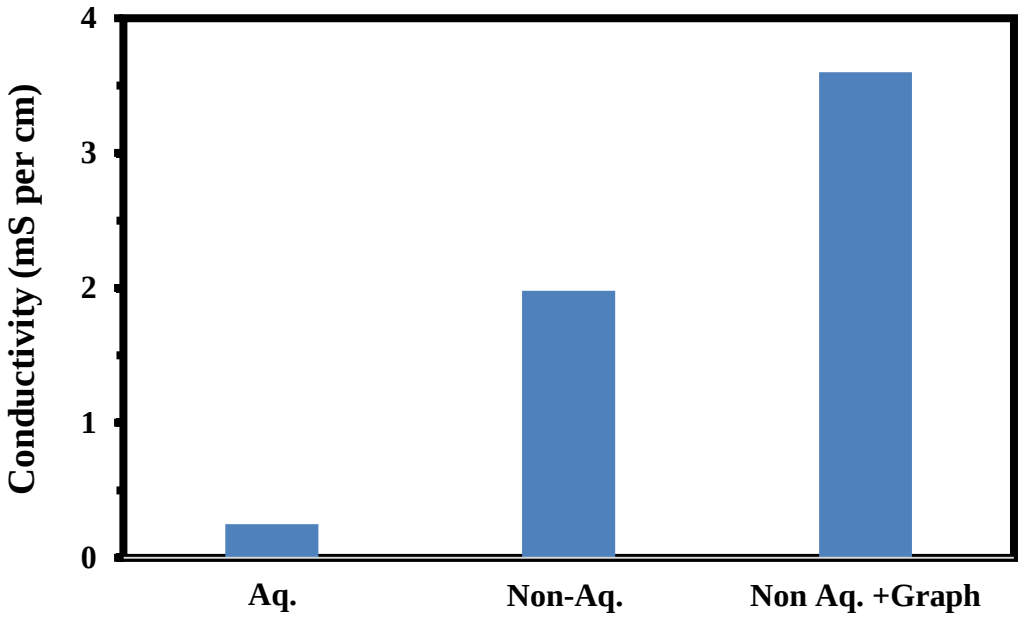

Fig. 47: Conductivity of different types of Gel Electrolytes

Conductivity of gel electrolytes are shown in Fig. 47. Aqueous gel electrolyte, non-aqueous gel electrolyte and non-aqueous gel electrolyte

with graphene is termed as Aq., Non-Aq. and Non-Aq.+Graph,

respectively. Conductivity of aq., Non-Aq., and Non-Aq. +Graph gel electrolyte are 0.25 mS/cm-1, 1.98 mS/cm^{-1}and 3.6 mS/cm^{-1} respectively. Conductivity of non-aq. gel electrolyte is higher than Aq. gel electrolyte because only small volume of liquid electrolyte is added to gel matrix. In case of non-aq. gel electrolyte, gel matrix of biodegradable agar-agar is prepared in liquid electrolyte only. Conductivity further increased when graphene (RGO S4) was added to non-aq. gel electrolyte matrix.

6.4 J-V Characteristics of different types of gel electrolyte DSSC

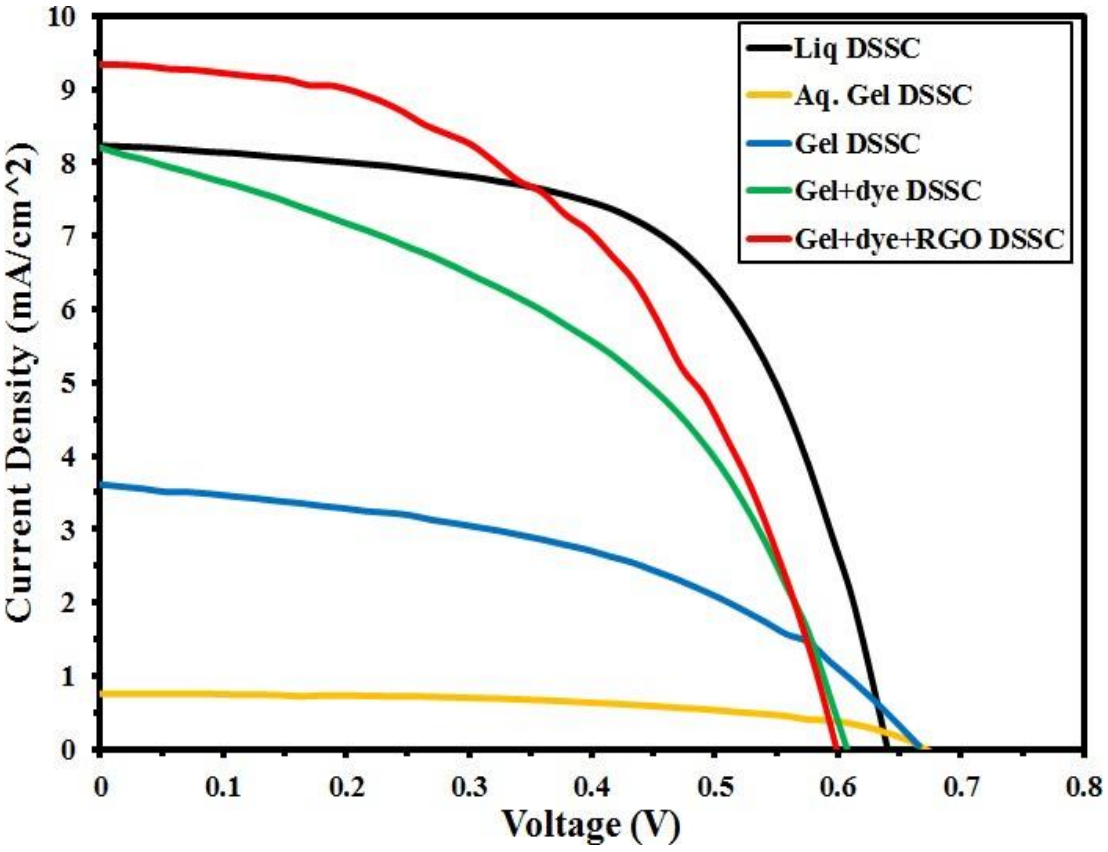

Fig.48: JV plot of DSSC fabricated using different gel electrolytes

Table 11: Jsc, Voc, FF, and η of DSSC fabricated using different gel electrolytes

Cell type	Jsc (mA/cm^2)	Voc (V)	FF	η
Liq DSSC	8.2	0.63	0.62	3.2
Aq. Gel DSSC	0.76	0.66	0.53	0.3
Gel DSSC	3.6	0.67	0.47	1.1
Gel+Dye DSSC	6.4	0.61	0.44	1.7
Gel+Dye+RGO DSSC	8.0	0.60	0.50	2.4

J-V plot of various gel DSSC is presented in Fig. 46. Jsc, Voc, FF and η values of all types of gel DSSC are listed in table 11. Detailed synthesis of gel electrolyte is discussed in chapter 3, section 3.3.3. DSSC incorporated with aqueous gel electrolyte, non-aqueous gel electrolyte, gel with dye electrolyte and gel with dye+graphene electrolyte is termed as Aq. Gel DSSC, Gel DSSC, Gel+dye DSSC and Gel+dye+RGO DSSC, respectively. Efficiency of aq. Gel DSSC is reduced to 0.3 % due to dye degradation. Very low efficiency of aq. gel DSSC is also due to dye desorption from anode to gel electrolyte. Efficiency of non-aq. Gel DSSC, 72. 7 % is higher than aq. Gel DSSC due to less dye degradation in non-aq. gel DSSC. Dye is added in gel electrolyte to stop dye desorption that has increased its efficiency from 1.1 % to 1.7 %. Adding dye has stopped dye desorption from electrolyte in liquid electrolyte DSSC (Discussed in chapter 4, section 4.3), also. Accordingly dye addition in gel electrolyte DSSC also stopped dye desorption challenge of DSSC. Dye was added in

same amount to gel electrolyte as it was done in liquid electrolyte case. Further graphene (S4) is added to dye+gel electrolyte, to further increase DSSC efficiency to 2.4 %. Adding graphene to liquid electrolyte has increased efficiency of liquid electrolyte DSSC (Discussed in Chapter 5, section 5.3). Properties of graphene were discussed in detail in Chapter 5, section 5.1. Most conductive graphene sample S4 was added to dye+gel electrolyte (preparation is discussed in chapter 3, section 3.3.3. Still most modified gel electrolyte DSSC showed little bit lower efficiency 8% than liquid electrolyte DSSC efficiency i.e. 3.2 %. FF values of all type of gel DSSC are less than liquid DSSC due to the fact the gel matrix offer more resistance to electron flow.

6.5 Stability of Gel DSSC

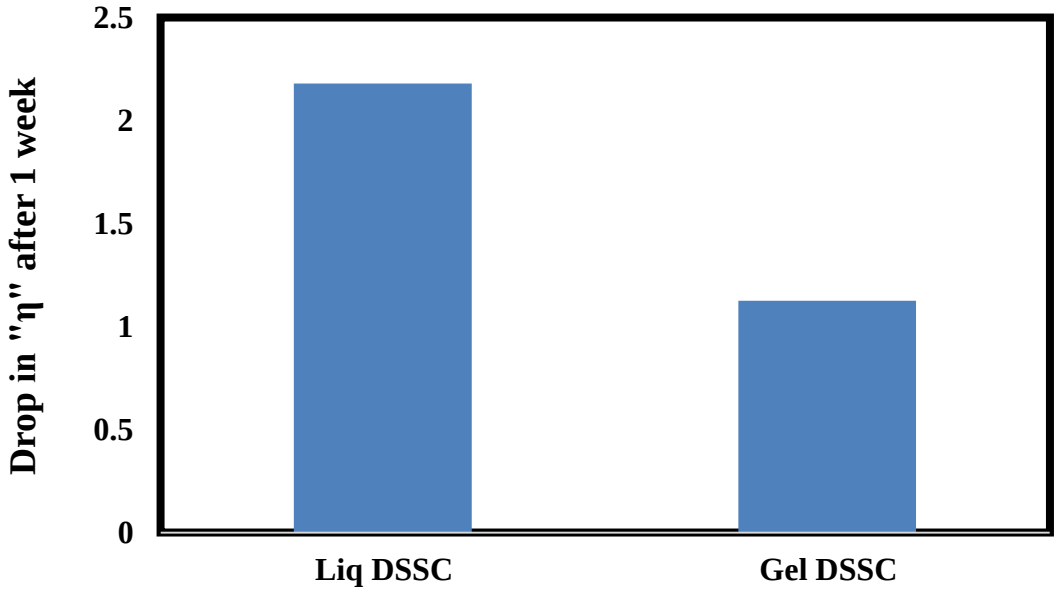

Fig.49: Bar graph showing drop in efficiency of liq and gel DSSC

Liquid DSSC showed leakage of electrolyte more as compared to gel DSSC. Therefore, drop in efficiency is almost half i.e. 50 % for gel DSSC as compared to liquid DSSC, where drop in efficiency is 31.3 % over period of 1 week.

6.6 Conclusions

Gel electrolytes with agar-agar powder are prepared in aqueous medium as well as non-aqueous medium. Modifications are done in gel electrolyte to overcome dye desorption and low conductivity challenge of gel electrolyte. Conductivity of gel electrolytes are measured. DSSCs were fabricated using biodegradable gel electrolyte and its performance are analyzed in terms of J-V curve. Efficiency of aq. gel DSSC is reduced to 0.3% due to dye degradation in aq. gel DSSC. Efficiency of non aq. gel DSSC is higher than aq. gel DSSC due to less dye degradation. Dye is added in gel electrolyte to stop dye desorption which has increased its efficiency from 1.1 % to 1.7 %. Further graphene is added to dye+gel electrolyte, to further increase DSSC efficiency to 2.4 %. Gel DSSC showed 50 % drop in efficiency after 1 week period.