

**FACULTY OF ENGINEERING  
UNIVERSITY MALAYSIA SABAH**

**INVESTIGATING THE PERFORMANCE OF DSSC BY  
INCORPORATING MODIFIED NANOSILICA SURFACE IN  
POLYMER GEL ELECTROLYTE**

**ASSOC. PROF. DR. COSWALD STEPHEN SIPAUT @ MOHD NASRI,  
ASSOC. PROF. ENGR. DR. RACHEL FRAN MANSA AND ASSOC.  
PROF. DR. JEDOL DAYOU**

**FINAL REPORT  
EXPLORATORY RESEARCH GRANTS  
NO. ERGS0019-TK-1/2012  
SEPTEMBER 2014**



**UMS**  
UNIVERSITI MALAYSIA SABAH

# 1 SYNOPSIS

## SINOPSIS

Dalam kajian ini, nanosilica atau nanosilica yang telah diubahsuai permukaannya telah dicampur dengan polyethylene glycol (PEG), 4,4'-diphenylmethane diisocyanate (MDI) dan propylene karbonat (PC) untuk membentuk 3 dimensi polimer filem yang mampu menyerap dan mengekalkan elektrolit cecair. Nanosilica telah disintesis melalui kaedah stober manakala permukaan nanosilica diubahsuai dengan APTES disintesis melalui kaedah pos pengubahsuaian. DSSCs telah dibuat dengan menggunakan 'fluorine doped tin oxide coated glass slide' (FTO) sebagai substrat, titanium dioksida sebagai semikonduktor oksida, N719 sebagai perwarna, dan FTO bersalut dengan platinum sebagai elektrod kaunter. Sampel telah dicirikan dengan mengguna ATR-FTIR, zetasizer nano, dan profilometer. Selain itu, penyerapan cecair elektrolit dan kekonduksian polimer filem telah diukur. Persembahan photovoltaic DSSC berdasarkan SA-MDI-PEG polimer filem menunjukkan kecekapan yang tertinggi di kalangan polimer filem yang lain, iaitu 2.79%.

## SYNOPSIS

In this study, nanosilica or surface modified nanosilica were blended with polyethylene glycol (PEG), 4,4'-diphenylmethane diisocyanate (MDI) and propylene carbonate (PC) in order to form 3-dimensional polymer thin film which were capable to absorb and retain liquid electrolyte. Nanosilica was synthesized through modified stober method while the surface of synthesized nanosilica was modified with APTES through post modification method. The DSSCs were fabricated by using fluorine doped tin oxide coated glass slide (FTO) as substrate, titanium dioxide as semiconductor oxide thin film, N719 as sensitizer, and platinum coated FTO as counter electrode. Samples were characterized by using ATR-FTIR, nano zetasizer, and profilometer. Besides, the liquid electrolyte absorbency and conductivity of the polymer thin films were measured. The photovoltaic performances of the DSSC

based on SA-MDI-PEG polymer thin film showed the highest efficiency among the other polymer thin film, which was 2.79%.

## 2 INTRODUCTION

One of the global challenges nowadays is the steady increase of energy consumption all around the world. Demand of the energy increases as the result of the increased of human population and the improved living standard. As estimated by the *International Energy Outlook 2013 (IEO2013)* [1], the energy consumption of the world will grow by 56% from the year of 2010 to 2040. The total world energy consumption will rises from 524 quadrillion Btu (British thermal units) in 2010 to 630 quadrillion Btu in 2020 and to 820 quadrillion Btu in 2040.

The main energy source for human is fossil fuels (petroleum, coal and natural gas) which are 83% of the total energy consumed. However, those energy sources will release harmful gasses such as carbon dioxide, nitrogen monoxide, nitrogen dioxide, sulphur dioxide and carbon monoxide when burnt. Carbon dioxide is the primary greenhouse gas that contributes to global warming. Carbon dioxide emission from the fossil fuel burning in 2012 was  $9.1 \pm 0.5$  GtC (billion tonnes of carbon). In 2012, coal burning was responsible for 43% of the total emissions, petroleum 33% and gas 18% (Carbon Dioxide Information Analysis Center, 2012) [2].

Due to the reasons stated above, solar cells have been promoted as one of the alternative energies. The development of solar cells is not only promoted by the urgent need of alternative energy that is zero harmful gases emission but also promoted by the increasing of public awareness that the fossil fuels (coal, petroleum, natural gas) resource could run out in the future. Fossil fuels are non-renewable resources. It takes millions of years to form and the reserves are depleted much faster than the new one being formed. Hence, renewable alternative energy such as solar energy attracts the attention and interest of the world.

Sun is the major source of energy for earth. It is a tremendous amount of energy around  $4.4 \times 10^{16}$  watts of power (National Aeronautics and Space Administration,