CHAPTER I

INTRODUCTION

Recently, the World Energy Outlook (WEO) predicts that under a business as usual (BAU) scenario, energy needs through the year 2030 will increase by 60 percent with the bulk of this growth to occur in developing countries. Fossil fuels, accounting for 85 percent of world primary demand are facing energy security problem. Meanwhile, renewable energy as a smaller percentage of total energy consumption will remain largely unchanged. Moreover, the bulk of renewable energy development to date has only occurred in industrial countries as it continues to be comparatively expensive for developing countries' needs (www.un.org/esa/sustdev/sdissues/energy/op/beijing_re_egm/beijing_re_report_pdf).

The fastest growing renewable energy technology in the world has been grid-connected solar photovoltaic (PV) cell, followed by wind power, biodiesel, solar hot water/heating, off-grid solar PV, geothermal heat capacity, and ethanol. Other renewable energy power generation technologies, including biomass, geothermal, and small hydroenergy, are more mature and growing more slowly at similar rates. It is important to note that traditional forms of biomass used are often not sustainable, while the more sustainable and environmentally sound-manner energy is needed. However, for many developing countries, PV system is still an expensive technology solution, being only affordable when no other solution is available, such as in remote areas (www.un.org/esa/sustdev/sdissues/energy/op/beijing_re_egm/beijing_re_report _pdf.).

Solar cells, also called PV cells by scientists, convert sunlight directly into electricity. PV gets its name from the process of converting light (photons) to electricity (voltage), which is called the *PV effect*. Traditional solar cells are made from silicon. Second-generation solar cells are called thin-film solar cells. Thin-film solar cells use layers of semiconductor materials with only a few micrometers thickness, and are made from amorphous silicon or nonsilicon materials, such as cadmium telluride. Third-generation solar cells are made from a variety of new materials besides silicon, including solar inks using conventional printing press technologies, solar dyes, and conductive plastics (www.nrel.gov/learning/re_ photovoltaics.html.).

A dye-sensitized solar cell (DSSC, DSC, or DYSC) belongs to the group of third-generation solar cells and is extremely promising because it is made of low-cost materials and does not need elaborate apparatus to manufacture. It can be engineered into flexible and work even in low-light conditions (cloudy skies and non-direct sunlight), which is currently proposed for indoor use by collecting energy from the lights for small devices in the house. Although its conversion efficiency is less than the best thin-film cells, its price-performance ratio (kWh/(m^2·annum·dollar)) should be high enough to allow them to compete with fossil fuel electrical generation (grid parity) (en.wikipedia.org/wiki/ Dye-ensitized_solar_cell#cite_note-10; Grätzel, 2001).

Several researches have been attempting to incorporate other materials which are wide-band gap semiconductors or insulators to form composites with main n-type semiconductor in order to enhance cell performance by suppression of electron recombination. This brings us to a material from nature which is *bentonite clay*. Besides its wide-band gap and insulation properties, high aspect ratio up to 2,000 is its superior characteristic to perform dual functions; light scattering center (size ~ 100-400 nm) and energy barrier (size < 10 nm) (Lee *et al*., 2006a).

Therefore, this study has been focused on an investigation of more cost-effective and more environmentally friendly DSSC devices. An indigenous natural clay in Thailand, i.e. bentonite, has been applied for making TiO_2/bentonite electrodes and improving electrolyte stability. In addition, extracted natural dyes, i.e. red cabbage, rosella, and blue pea dyes, have been employed as sensitizers for the DSSCs. The influences of clay in photoanode films as well as in gel electrolyte on photovoltaic properties were revealed. The cell stability of gel electrolytes of CTAB-bentonite and laponite under sun simulator was tested. In addition, gel electrolyte prepared from polymethyl acrylate/bentonite aerogel composites were investigated in terms of rheological properties and diffusion conductivity in order to search for an appropriate gel which could be applied in the cell easily and render the high DSSC performance.