Tentative Proposal

Title : Development of electrochromic glass for daylighting applications in atrium building in tropical climate

Name : Mr. Nontivat Inklab

Advisors : Dr. Pipat Chaiwiwatworakul (Main advisor)

Dr. Surawut Chuangchote (Co-advisor)

Background and Rationale

Glazed windows are the critical component of building envelope that influences highly on the building energy demand [1]. In the tropics where skylight is voluminous and the sun transverses in all directions, windows with properly designed shading introduce effectively exterior daylight to illuminate an interior space jointly with light from electric lamps including protecting building occupants from glare situation [1, 2]. In tropical Thailand, large glazed windows and curtain facades with no external shading are currently popular envelope features of commercial buildings and even residential houses [1]. To avoid adverse effects of excessive solar gain, low optical transmittance glassed are recommended for the usage. This practice leads to loss of beneficial gain from the daylight use including connectedness between the occupants and exterior scene. Such building also need full reliance on electric lighting even when the daylight is sufficient for the illumination. Practically, lighting systems of Thai's commercial buildings are designed based on uniform lighting concept. Dimming control is not common feature of lighting system in the buildings.

Nowadays, there are several technologies to control the dimming in buildings for making thermal and visual comforts; one of the alternative solutions is the use of energy saving glazing or smart windows. The energy saving glazing can generally be made from liquid crystals, electrophoretic or suspended particle device, and chromic materials (color-reversibly changeable materials). However, electrophoretic or suspended particle device and liquid crystals are not appropriate to use in the building because the electrophoretic or suspended particle device requires electricity to stay clear windows while the liquid crystals cannot prevent much solar heat/light entering though windows even in cloudy white mode and it requires constant energy supply for electrical field to keep the transparent window. So chromic materials are possible interested for this application.

Commonly, chromic materials for smart windows application can be classified into 3 main types, *i.e.* (1) electrochromic, (2) thermochromic, and (3) photochromicmaterials. For thermochromic material, it can color-reversibly change by temperature change or heat. The advantages of this material are low cost and uncomplicated in preparation process. On the other hand, after using this material in smart window applications, it is not durable and the change of color cannot be controlled and not smooth. The second type of chromic material is photochromic, it can easily reversibly change by light but it is very hard to control the color change. Finally, if the electrochromic material is applied for electrochromic windows, it is relatively complex with multilayer as shown in Figure 1.

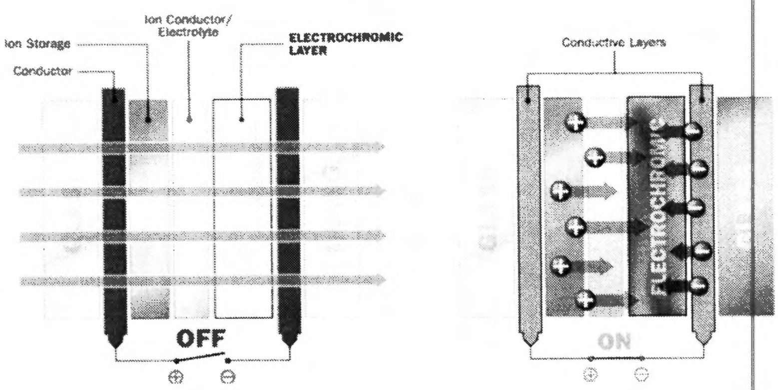

Figure 1 Multilayer of electrochromic windows [3]

Regardless some disadvantages discussed above, when consider the advantages of the windows made of electrochromic materials, they are very interesting because it can not only be color-reversibly changed with light and thermal through a sensor, but it can also control the switching mode for real time adjustments of the glazing. Both of benefits are appreciate for the currently use while themochromic and photochromic technologies are not be able.

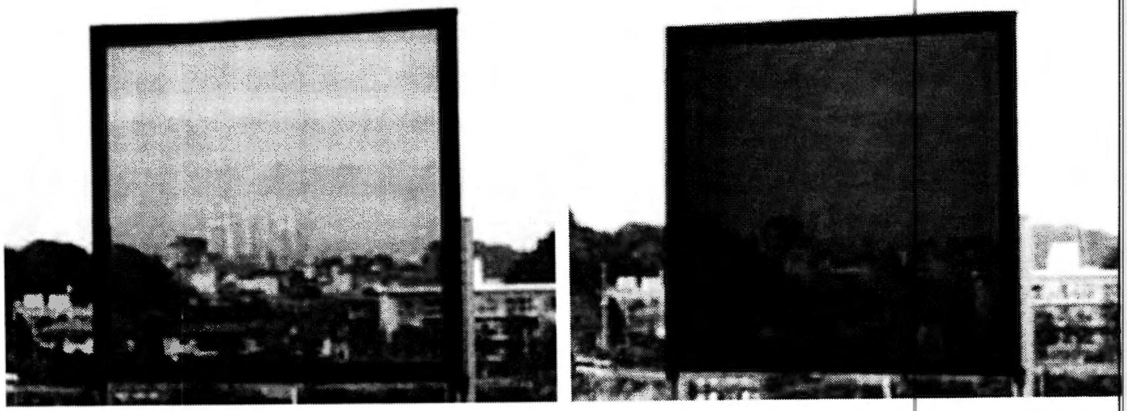

Figure 2 Examples of commercial electrochromic glass [3]

From the rationale mentioned above, this research work will be focused on preparation of electrochromic materials in small-area of glazing and expected to fabricate in the large-area for smart windows. Finally, this study also intends to focus on applying the developed electrochromic windows with computer model and compared with commercial available ones.

Objective of the Study

To develop electrochromic glass for daylighting applications in atrium building in tropical climate.

The specific objectives are:

1. To develop electrochromic materials for uses as electrochromic glass.
2. To characterize optical properties of developed electrochromic glass.
3. To evaluate the potential of the applications of developed electrochromic glass for skylight applications in atrium buildings in tropical climate.

Methodology

1. Study on the literature and preparing instrument and other chemicals for experiments.
2. Preparation of the electrochromic materials with varied conditions. The interested materials are tungsten oxide (WO_3) (transparent ↔ deep blue), nickel oxide ($Ni(OH)_2$) (transparent ↔ grey/brownish), iridium oxide (transparent ↔ brown), polyaniline (PANI) (transparent ↔ violet) or poly(3,4-ethylene-dioxythiophene)(PEDOT) (blue ↔ transparent). The properties for the selection should involve durability, stability, reasonable cost, and wide range of transmittance.

3. Characterizations of the electrochromic glass. Light properties, *i.e.* solar and visible transmittance, absorbance, and reflectance (in the range of UV, visible, and IR) will be characterized.
4. Applications of the prepared electrochromic glass for skylight in atrium buildings (idea) (see Figure 3)

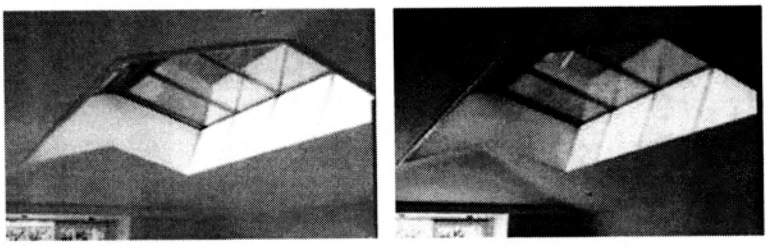

Figure 3 Examples of color-reversibly changeable electrochromic glass for skylight applications in building [4]

Expected Results

1. The electrochromic glass can be developed form suitable electrochromic materials.
2. The appropriate optical properties of developed electrochromic glass can be obtained.
3. The developed electrochromic glass can be applied for atrium building.

References

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