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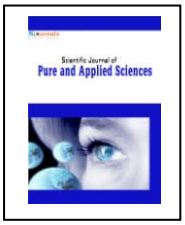
Scientific Journals
Scientific Journal of Pure and Applied Sciences (2014) 3(7) 529-537
ISSN 2322-2956
doi: 10.14196/sjpas.v3i7.1566

Contents lists available at Sjournals
Scientific Journal of
Pure and Applied Sciences
Journal homepage: www.Sjournals.com



Original article

An exposition of the role of external base absorbent of solar energywithih ntellegent constructional structures with a view to reduction in energy use

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ARTICLE INFO

Article history:
Received 21 June 2014
Accepted 20 July 2014
Available online 25 July 2014

Keywords:
Smart buildings
Smart glass
External ducts
Solar energy
Reduction of energy consumption

ABSTRACT

There is no doubt that one of the most important challenges facing engineers and designers of architectural design and engineering is indeed the problem of energy. It is in line with this trend of thought that energy can be seen as a critical element with a view to the enhancement of mans economical and social welfare and it is in the sphere of construction engineering that the need arises for the use of the appropriate construction material which can best serve this vital aim of energy conservation by using renewable energy sources such as solar energy. It is therefore a foregone conclusion that the more we are capable of using solar energy we are helping to conserve our other energy sources and thus help to reduce our overall energy consumption. It is with this view in mind that construction engineers and those working in building design have aimed at using systems that can manage energy consumption within their constructional structures, having arrived at a point where their building designs can actually be termed intelligent or smart constructionalstructures, whereby the system as a whole is capable of using solar energy instead of the traditional fossil

fuels. Yet that which makes possible the use of solar energy more so today than ever before is the use of external ducts, which are installed in places most exposed to sunlight, and have the capability of changing color and becoming lighter or darker as the state of exposure calls for is the use of a certain type of smart glass within the built structure, that makes possible the most efficient use of sunlight entering the building, having the capability of changing color in correlation to the amount of sunlight received and becoming lighter or darker appropriately, allowing that quantity of sunlight to enter the building as is needed to counteract the greenhouse effect which causes an uncontrolled increase of temperature within the built structure, and thus allowing the most efficient use of solar energy in keeping the place pleasantly warm in winter and cool during the summer months. It is therefore from this perspective that we have through the use of library studies embarked on the investigation of the particular structural make up of this type of smart glass with the capability of structural change in its color variance which counts as the most important compositional part of smart buildings, to explicate the mechanisms at work and the benefits acquired from the use of such ducts within a smart constructional structure as a practicaltechnique in line with reducing energy consumption so that designers of any type of construction may make efficient use of this technology.

1. Introduction

The built in limitations in the use of natural energy sources together with the high costs involved in manmade energy, has encouraged construction engineers to review the various dimensions of their designs while keeping in mind the topic of energy consumption management and following this to find new ways of reducing energy consumption. They have thus arrived at a solution by adapting their designs by giving them the required sensitivity to change according to the potential of variability of the surrounding environment and as such they have come to design the smart structure which aims itself at reducing energy needs through controlling its input. However the use of smart structures in buildings must first and foremost be applied on areas which are most prone to causing energy loss and wastage. Researchers have thus found the outside layers of buildingsand specifically the areas covered with glass to be the major culprits in causing energy loss being responsible for wasting more than 30 percent (a third of the energy used in the building). It was with this fact in mind that construction engineers saw the need for adopting newer designs of smart glass in order to make efficient use of solar energy as a renewable energy source in order to reduce our overall use of non-renewable fossil fuels within buildings.

Therefore the last recent years have witnessed a marked increase in the use of smart windows. Imagine types of buildings which have their windows equipped with a kind of glass that changes in color with respect to the intensity of the sunlight it receives getting lighter and darker accordingly. The technology used in the smart window can during the hot summer days when there is intense reflection of sunlight entering buildings and the need for the use of air conditioners and cooling systems increase, to cause a reduction of sunlight entering the building by allowing the glass to take on a darker tint thus confronting the sun's intense reflection on the widows and similarly during the winter months allow more sunlight to enter the building through the windows which become lighter in color. This technology has had an astonishing effect on the control and management of energy use, causing a marked reduction of

the usage of fossil fuels. It is evident that the use of smart glass in a building in addition to reducing energy consumption can create a more agreeable environment for its residents.

2. Fundamental parameters for the categorization of windows in terms of energy efficiency

2.1. The rate of air leakage

Heat wastage and the warmth of the sun entering a building causes air displacement through certain openings and crevices existing in various parts of windows. Taking this into account in order to examine the efficiency of windows, the rate of air leakage is used as a parameter of comparison. Low air leakage is expressive of air displacement leaking through the crevices of windows.

2.2. Coefficient of visible transmittance of light

The coefficient of the visible transmittance of light depends on the optical characteristics of the glass layer and the coefficient of a higher transmittance of visible light throughout the day. Windows with a high transmittance capability are more appropriate with regard to greater visibility and maximal use of sunlight during daylight hours.

2.3. Coeffient solar heat gain

The solar heat gain coefficient of the sun's radiation speaks of that part of the sun's thermal energy resulting from direct reflection of the sun's rays that passes through the windows and enters a room or is absorbed by the glass layer and the residue is transmitted to the room. A lower solar heat gain coefficient (SHGC) tells us of a lower degree of the sun's heat entering the building.

2.4. The coefficient of an overall thermal transferance (u-factor)

A drop in heat temperatures from a window is stated through the coefficient of a general transfer heat through the windows. The extent to which the window is insulated guarding against heat loss is stated through the coefficient of thermal insulation (R-value) whereby the coefficient of thermal insulation stands in a reverse relation to the coefficient of the transmittance of heat. A higher thermal insulation coefficient in windows is telling of a lower rate of heat exchange occurring between a room and its external environment (Gharavolbashi, 2012).

3. The various types of smart glass technology

3.1. Thermochromic glass

Glass that changes in color in accordance to the changes in heat regulated so as to serve particular thermal perimeters. This type of glass contains USER material which has no electrical current and no particular polymeric command which becomes integrated in low temperatures and expanded and diffused in high temperatures and this in itself causes further diffusion of heat.

3.2. Gaschromic glass

Multi layered glass (at least 2 layers) covered by a certain type of sealant and with different types of gas injected in between the layers.

3.3. Liquid glass

By controlling the transmittance of light through the various layers and the coefficient of different fractures of rays within layers is caused a positive interference in the visible transmittance of light.

3.4. SPD glass

The modus operandi or the mechanism of performance that need to be manually controlled using expensive equipment such as SPD plated which are used for different poisonous products and which are therefore prone to rapid decay.

3.5. Electrochromic smart glass

Electro chromic smart glasses are the types of glass which change in color in accordance with variances in electric current, they have only ON and OFF positions with no middle position, yet when put in a smart state this type of glass does have a desired middle position and of its benefits we can point to

- Their memory, for example we may turn the glass blue and if suddenly the electricity is cut, it will take almost 2 days for it to change color again.
- Low voltage consumption. These are multi layered glass types with each layer performing a specific task (Dussault, 2011).

4. The most efficient type of smart glass for the reduction of energy consumption

Since taking advantage of smart glass has seen an increase in usage, however among all the various types of smart glass the one that has been the most popular is the smart glass that at the same time has the capability of reducing energy consumption. As such among the various types of smart glass available within the technology this kind as has been mentioned earlier, the electro chromic smart glass in addition to controlling the visible transmittance of light, can also control temperature. From among the various kinds of smart glass for the purpose of reducing energy consumption which is made to be fitted on the external partitioned layers of a building this type is seen to be the most favored. This is due to the fact that this type of glass is capable of adapting itself by changing its color in such a way as to keep the desired transparency automatically and this allows only a small amount of light to enter into closed spaces preventing excessive heat from entering the rooms. Also during the time that the sun's radiation due to the angle this always fiery planet finds with respect to earth and when the intensity of the sunlight is markedly reduced, this type of glass can during the cold winter months while allowing the available visible light to enter into enclosed spaces, play a striking role in causing a reduction of the energy consumption of the buildings utility facilities both in the cooling and heating systems, and it is due to this impressive dual action that this type of smart glass can act as a regulatory module in adjusting the amount of light and heat entering a room and thus greatly reducing costs relating to the use of air conditioning systems in houses and even in service and utility spaces(Gavrilovice, 2011,3). in view of the aforesaid we shall continue our investigation with the examination of the mechanism involved in the working of the electro chromic smart glass which through the use of an electric current has the ability to become lighter or darker and also show a case example of the practical application of this type of glass and the appropriate way in which it has been able to prove itself as the most convenient approach in the quest of reducing energy consumption and creating an enjoyable air conditioned living environment.

4.1. The mechanism of electro chromic smart glass

The electro chromic smart glass contains certain electro-chromic material. Electro-chromatics are materials which change in reaction to the flow of electrical current .The flow of electricity while causing a chemical reaction to occur is also responsible for changes in the characteristic makeup of materials causing them either to absorb light or to reflect its radiation. Today the electronic industry plays a major role in the production process of this type of glass used in windows. T5he sun's rays are reflected onto this glass, but at the same time the established flow of electrical current causes the ion reserve layer to be conducted returning towards the electro-chromatic layer leading to achievement of a greater transparency in the glass. With the cutting off of electricity a reversal of the process causes the glass to become darker again. A specific feature of electro-chromatic materials is their regulatory ability, such that the intensity of opaqueness changes with changes in the measure of the flow of electrical current running through the system (Figure 1)(Gavrilovice, 2011,3).

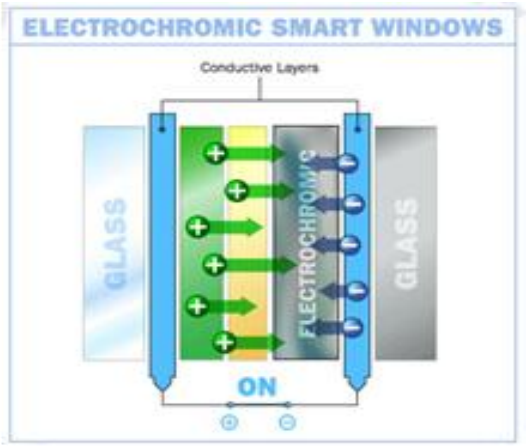

Fig. 1. Simulated illustration of electro-chromic glass (Gavrilovice, 2011).

5. The mechanism of electro-chromic smart glass (of the liquid crystal kind)

The inner structure of this type of glass is made up of two transparent layers of tin acting as a kind of electrode in coating with a layer of liquid crystal sandwiched in between. In this type of glass. In this type of glass transparency is achieved by passing an electric current through a film of liquid crystal. Along with the cutting off of the electrical flow, the crystals are dispersed in a haphazard manner positioning themselves in every direction and deflecting the light rays in the process thus causing the glass to take on a mat texture (Figure 2).

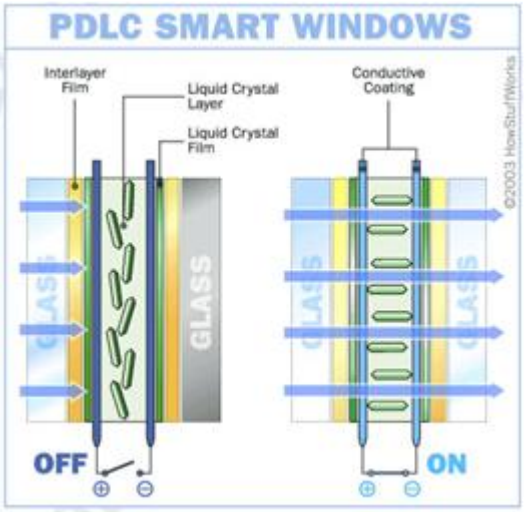

Fig. 2. An illustration of the mechanism in electro-chromic glass (of the liquid crystal type).

This technology has many applications, for example imagine a kind of glass which has the ability to change from transparent to opaque through the use of a switch (Figure3).This glass can be used for windows in a house (in case there is a need to have no visibility) for the front view of shops at night and also in bathrooms. Although individual private use of this type of glass is not quite wide spread as yet, nevertheless there exists a variety of specimens throughout the world (Wang, 2011, 6).

Fig. 3. The mat and transparent state for electro-chromic glass which changes with the pressing of a switch.

5.1. The advantages of using the smart electro-chromic glass

Among the most important of the advantages of this type of glass used today are their multi purpose actions in for example, residential areas and service areas, we can refer to cases listed below:

- Maintaining a comfortable temperature in winter
- Maintaining a comfortable temperature in summer
- Decreasing the annual costs of energy
- Lessening heating and cooling expenses of these systems
- Confronting the admission of the sun's harmful radiation
- Providing suitable lighting in buildings
- Reduction of expenses needed for lighting
- Preventing the glass from steaming up during the cold seasons
- Reduction in noise pollution

5.2. A case example of the advantages of the applicational usage of smart electro-chromic glass

The (Chabot college)1and the center for student services CSSC has an attendance rate of almost 15000 students , employees and teaching staff, in view of this the designers wished to come up with the plan of a design for a center using the most recent and up to date application methods available. For instance they wished to design an Atrium which would use natural light and energy for the cooling and heating systems using the suns radiation to accommodate a totally natural air conditioning system in the best possible manner.The CSSC Atrium included a wall façade with a height of 2900 square feet adjoining south to west without creating an obstacle, allowing easy accessibility for users of sights within the college perimeter and grounds. This Atrium directs natural light to an inner space reducing the need for having a synthetic lighting system to minimum. The Atrium's situation presented its own challenges such as high intensity of brilliancy of the sun's rays which in turn causes the generation of excessive heat. A particular challenge facing designers was to provide easy accessibility to the outside landscape and sights and also keeping the temperature at a pleasant level for the welfare of the buildings residents. The designing group decided to face these challenges by using (Dynamic glass), altogether the Atrium building opted for the use of electro-chromic windows in order to use energy efficiently and by doing this they managed to achieve a striking reduction in energy costs, this being made possible through the use of a natural air-conditioning and heating system using solar energy. Electro-chromic windows automatically change color throughout the day and together with the façade of the Atrium through the phenomenon of staring and absorbing, control heat emissions from the sun.

[1] Chabot

SAGE GLASS is used in the Atrium CSSC building. Making use of natural radiation in the running of the cooling and heating systems helps to control the air temperature. Electro-chromic windows help air circulation inside the building and whenever air finds its way through the roof into the building, the amount of heat which enters inside through the windows is circulated throughout the Atrium space with the aid of the heating and cooling systems. With the aid of the ventilation systems the air becomes either cool or warm and is then let out. This is done by making use of the existing pores and crevices existing in a building without using the ventilation system. With the application of SAGE GLASS in the windows of the Atrium creating a unique ventilation system there was no need of an HVAC system and this in itself has made economizing on energy costs possible(Wang, 2011, 6)(figure 4).

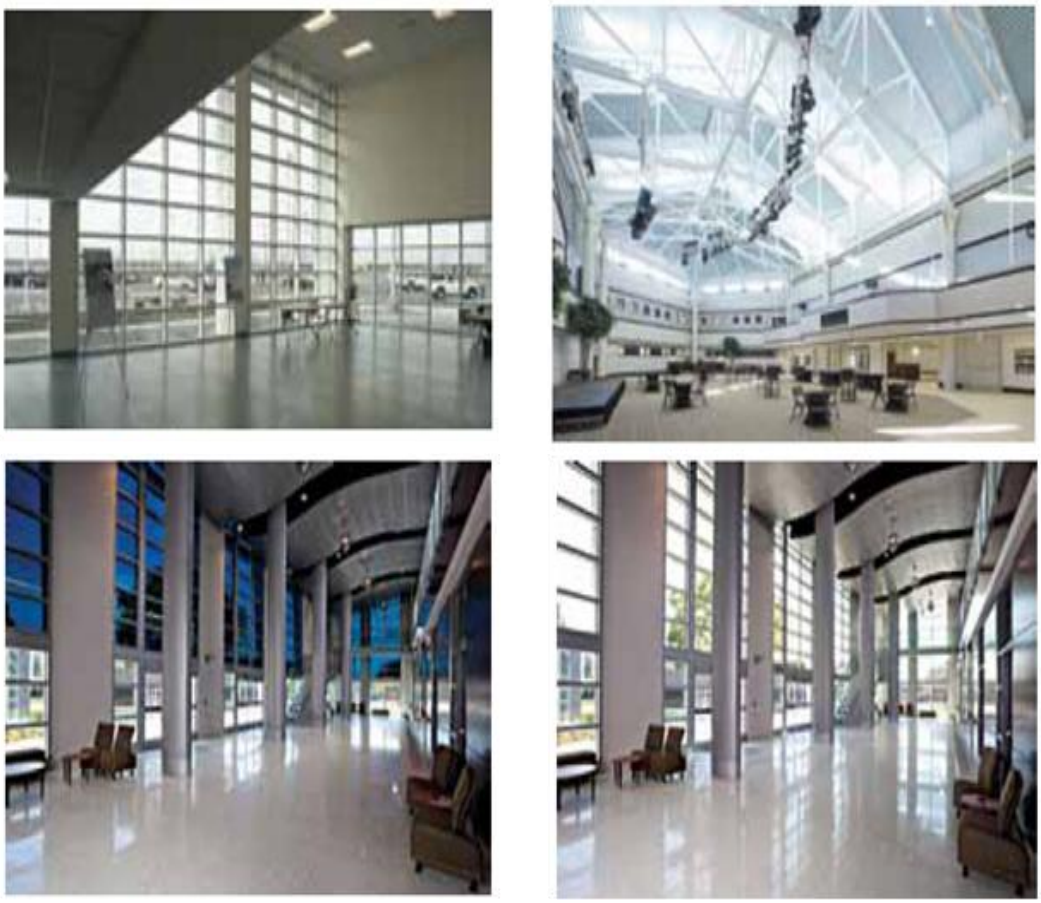

Fig. 4. making use of smart electro-chromic glass in Chabot College (Wang, 2011).

5.3. Different applicational uses for electrochromic smart glass

Today in shops selling clothes, the changing rooms are equipped with this type of glass also used in the design of partitions used inside a building (figure 5).

With this system it is possible to economize millions of dollars on the heating and cooling and lighting systems. At present smart glass windows are used in some types of buildings, these make possible a reduction in the consumption of energy. To do this, the windows keep the cooler air inside these house, controlling the amount of light entering inside (figure 6). One of the cases where this application has been most welcome is in museums where this type of window is used efficiently where the admission of excessive light can damage the expensive collection of artifacts kept for safe keeping.

Fig.5. making use of electro-chromic smart glass as partitioning space.

Fig. 6. making use of electro-chromic smart glass for control of lighting in houses.

6. A bright future with electro-chromic smart glass

Electro-chromic glass has a particularly bright futur4e within the construction industry since this type of glass changes as an effect of its reaction to the intensity of the sun's radiation getting darker and lighter thus making the home environment a more pleasant place for its residents. During the darker hours they act so as to absorb a greater portion of solar energy, in the second position this measure reaches its maximum level and it acts exactly as if they were solar cells. In this manner energy is saved in the glass and is then transformed into electrical energy and is then transformed into electrical energy and is then used to operate the air conditioning and lighting systems. Still this is not yet a comprehensive option open for everybody using this glass in their windows in addition to being able to pick their color of choice can also order their own favorite patterns to be imprinted on them. In offices for example during the summer months when the sun's radiation causes a great deal of heat to enter the building making life difficult for employees who have to spend 8 hours behind a desk. Smart glass can reduce the intensity of the sun's radiation while using that same energy as a deposit for operating the air conditioning systems.

It is foreseen that in the near future this type of glass will be used regularly in buildings specially in towers and high rises all over the world. According to the experts, at the same time as the specter of the energy crisis is on the increase, any idea which can cause relative relief of the situation can be most helpful and attractive. The dilemma that according to experts is in need of immediate attention is the expenses that go into the production of the finished good and that too seems to be moving in a favorable direction specially with regard to the recent progress made in the field of (Materials), It seems that the science of Materials as such will soon become part of history and extinct. Today the application and uses made of smart electro-chromic glass is not limited in its benefits only as a case for reducing energy

consumption, but with this type of glass in addition to the advantages of having an energy reserve any individual can adjust to their own liking the amount of sun they wish to have reflected and the intensity of its brilliance and the heat that is passed on. Therefore this type of glass has found its own special place all over the world and in some countries of the developed industrial world it is at this moment being used in the construction and the car industry (Mokhtarian, 2011,10).

7. Conclusion

With regard to what has been said about smart glass. Making use of electro-chromic smart glass due to its capability in giving a darker or lighter tint and thus controlling the light rays emitted by the sun providing a controlled environmental temperature and helping in the reduction of energy consumptionand since this product is fixed on the outside of buildings it is an efficient application for that purpose. On the other hand, of the most important applications of electro-chromic smart glass and one which makes it attractive for architectural designers and engineers alike, is their ability in creating a visual spectrum by using glass in a vast expansive manner to take advantage of the striking effect it creates and to make use of that material namely glass that has been traditionally seen as a no go situation type material for hot climates. Today through the ability of controlling the extent and intensity of sunlight and creating a mat or opaque texture and the desired color to the highest level of allowing visible transmittance of sunlight, a level of comfort can be achieved which has up till now been an impediment, while at the same time allowing us to save on the non renewable energy sources of our world.

It is therefore with this in mind that for us as a nation concerned with and responsible for the well being of our environment making use of this type of glass on the a surface that constitutes the outer layer of a building, and where we have almost 300 days of full sunlight in a year, a step that must be taken and the technology allowing dramatic reductions in energy consumption and confronting not only wastage but in fact making advantage of the advantages achieved through the adoption and employment of this innovative use of glass seems to be more than just a matter of taste but rather it must be looked on as a vital need.

On yet another level making use of an application offered to us by the possibility of using this type of glass inside a building we can take advantage of it as a novel method of creating partitions with minimum “pert” in space. We can therefore say that with electro-chromic smart glass if used on the outside of a building it will be serving as a material for reducing energy consumption and once used inside a building it can serve a multi functional task of creating the ideal material for creating partitions while keeping the benefits of allowing room for better visibility not to mention the space that is opened up for the designer to show creativity while saving on costs both at the same time , a potent duo which is what makes electro-chromic glass a highly efficient and practical multi- purpose and fully adaptable product and within its milieu a highly efficient and functional application to be adopted.

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