

## USAGE OF "SMART" GLASS PANELS IN COMMERCIAL AND RESIDENTIAL BUILDINGS

*UDC 666.185:725:728=111*

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**Abstract.** *This paper examines specific conceptual approach to the implementation of new "smart" materials having phase-changing own characteristics and maximum potential for their installation and exploitation of their performance in the commercial and residential buildings architecture. Such approach somewhat changes the usual traditional practice of installing "classical" materials, i.e. installable components into the architectural structure. The immeasurably superior performance of new elements installed in the architectural system is thus utilized, to the total energy benefit of the structural system.*

*Using new "smart" components would result in energy cost-effective impact, reflected in the reduced the overall energy consumption of a given structure as well as in better effect sustainability of buildings in bioclimatic terms at the micro and macro levels in comparison to the usual performance of traditionally constructed buildings.*

**Key words:** *new components, transparent barrier, special glazing, smart materials, variable properties, glass partition.*

### 1. INTRODUCTION

The requirements of modern architecture nowadays differ from the "modern" architecture of the previous century or medieval and ancient times. This fundamental diversity is reflected not only in the functional organization of the use of space and formal entities, but it is reflected in a new conceptual approach to the functional organization of the use of space and its specific units, the meeting of special requirements for the living comfort in such areas, applying new and complicated spatial design forms of users and application of new more flexible and cost-effective building systems and appropriate modern materials. One of the eternal and challenging issue in architecture is still topical and that is to maximally utilize the available space and meet the desires and needs of users of the given space.

Modern technologies nowadays, have facilitated production of a wide range of different types of materials that can successfully be implemented in building construction bringing about better performances in comparison to the previous generation of materials. In this process were developed various types and kinds of glass and plastic "panel" materials, in a variety of colors and shades, surface treatment, with application of screen printing, application of foils of various desired colors as well as the capacity of glass surfaces to sophisticatedly change their own colors and transparency [1], [2], [3]. Glass in architecture is one of the primary materials and it is successfully applied for making interiors, partitions, and panels in desired designs, then in making doors, stairs, eaves, floors and ceilings, in combination with light effects, which become a powerful visual tool of architects.



**Fig. 1.** The use of new materials in building architecture.

In the architectural design glass panels are mostly used in the external cladding as the "glass facade" and for glazing the windows of various sizes. As the glazing plays an important role in the total energy balance of a building, it is particularly addressed by the EU Code about energy savings of 2002, which stipulates that the heating of buildings should be designed to take into account the energy balance of the facility, if the surface area of glazing exceeds 30% of the facade. The sun irradiation energy increase must not exceed the maximum value  $S_{max}$  prescribed by this standard scale.

## 2. "SMART" PANELS WITH VARIABLE FUNCTIONAL CHARACTERISTICS

Modern technology every day produces a multitude of new materials whose use can always be incorporated in several industrial spheres. One of large users of a wide range of products is construction industry which is the multidisciplinary branch of economy. There is a small number of construction elements in contemporary architectonic practice, which have not undergone considerable modifications in technological and formal terms, aimed at maximizing their workability.

One such product is glass which, being present for a millennium in construction engineering practice, went through great transformation in terms of its basic functions and the overall range of possible applications.

In terms of energy, various glazed openings in buildings of have always presented problems to architects, as the attempts to design larger aperture in the facade of the building so as to provide a visual connection with natural environment meant increased cooling of the area and creation of energy inefficient structures. Nowadays, architects do not have to worry about that "unsolvable" problem because there are smart glass elements which, automatically, react to warm/cold environment and provide illumination and dimming of the area.



**Fig. 2.** Office building facade clad in "EC" glazing.

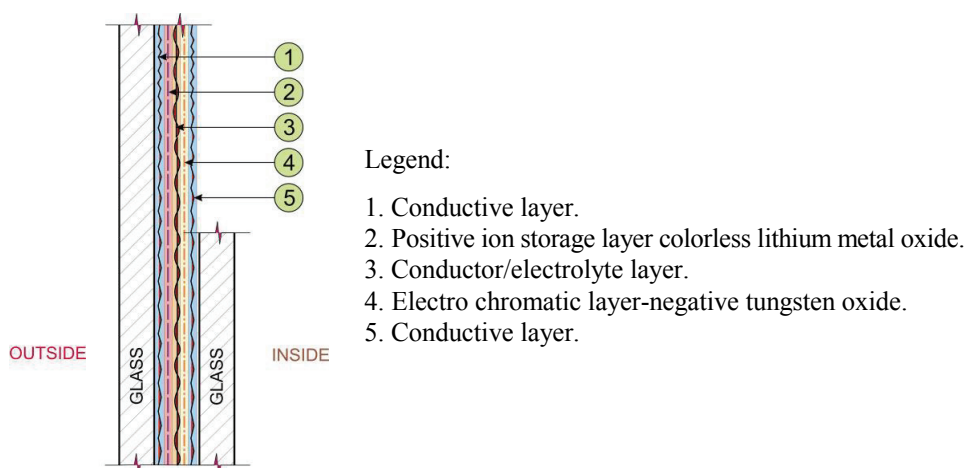
One of the most efficient modern materials as "panel" surface is the "EC" (electrochromatic glass) specific for being able to be both transparent and opaque by using electric power. Its operation can fully regulate daylight penetration and influence the percentage of dimming of the building interiors. Such glass "walls" in contemporary architecture are also called the "smart windows". Single traditional clear window paneglasses, trans-

mits a large fraction of the solar spectrum and at the same time absorbs (not reflect) much of the low-frequency infrared radiation tending to keep it inside. This feature is good in winter when we need heat, but in turn has an adverse effect in summer, when we need cooling. The new technology of glass panels is based on liquid crystal-based systems, and the main characteristic of such technology is that it changes from the partially translucent to transparent and on photo chromic glass that darkens in the sunlight. Using these materials for construction of commercial and residential buildings may reduce the total energy consumption of the buildings so as to achieve energy benefits.

Two different "high tech" technological systems are very suitable for application in modern architectural design: metal-oxide products and the suspended particle device (SPD). Panels of these two systems have different characteristics in terms of operating principle, composition, performance, control options, presence in practice.

### 2.1. Exterior MOEC glazed panels

The technology comprises applying five specially deposited thin metal-oxide layers in vacuum between two glass panels (see Fig. 3). Such a glass panel is very suitable for use in cladding the external structure apertures, i.e. for the large glass facades, without fear of "having" the effect of additional warming (green house effect).



**Fig. 3.** Scheme of the basic structure of MOEC (metal oxide electrochromics) glass panel.

Depending on the application of color in the layer of lithium metal oxide, we will also get a coloring range of choice [4]. MOEC (metal oxide electrochromics) glass panel is able to let through up to 62% of daylight when clear, and up to 3.5% when fully dimmed.

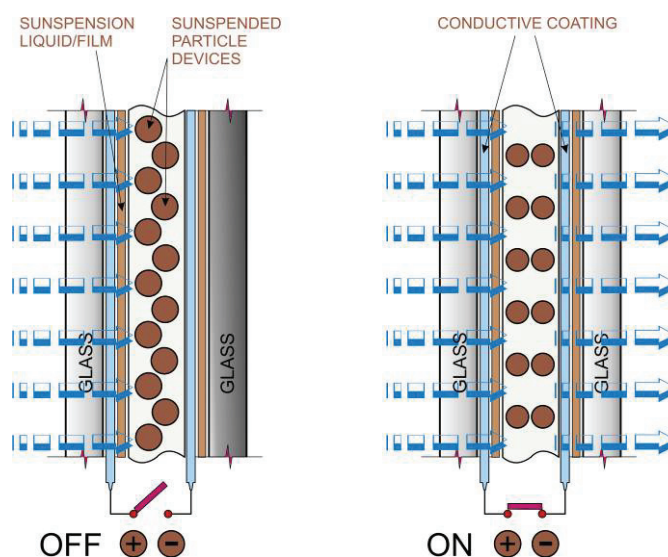
Electrica power required for supply and control of the system for the glazing having 140 m<sup>2</sup> (approximately 100 small apertures) per day is less than the consumption of a 60 W light bulb. The system does not consume electricity when the glazed facade surface or of window openings are fully clear. The particularity of metal oxide electrochromic glass systems that it remains functional, clearing and dimming the surfaces in more than 100,000 cycles. Research conducted by ASHRAE in practice on facilities where MOEC

glazed "smart" panels were installed indicate a significant reduction in winter heating season and in summer for cooling energy consumption [5].

It takes 5 minutes to fully dim the completely clear MOEC smart panel on a small building facade. The dimming effect starts at the perimeter of the panel, and gradually ends in the center of it. For larger facades the dimming effect lasts slightly longer. In case cloud cover and sunshine change in quick succession, panel transparency change effect is minimal.

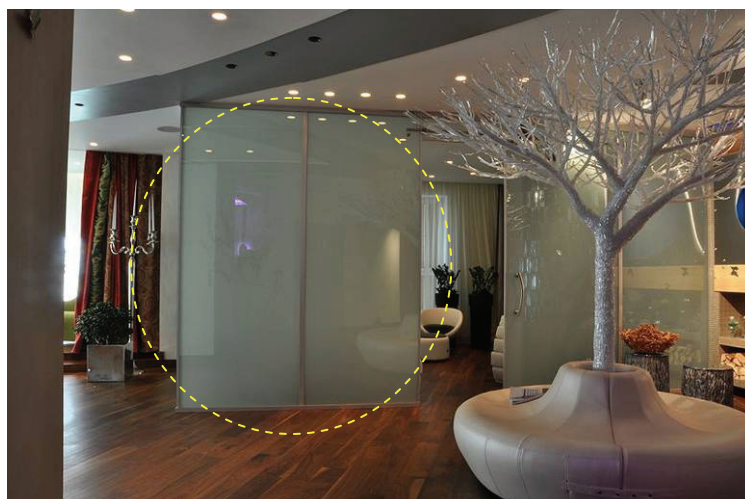
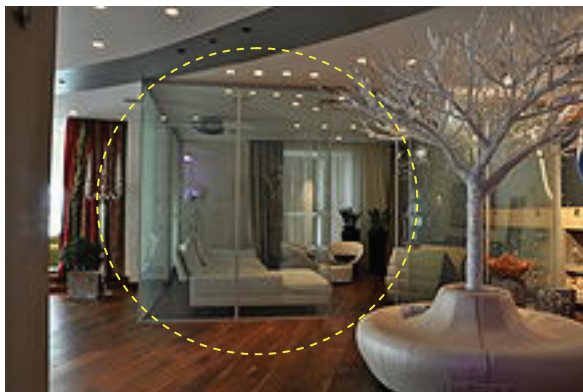
## 2.2. Partitions based on SPD technology

Panels based on SPD technology consist of two glass or transparent plastic surfaces with special conductivity coatings on the panel interior. The coating film consists of tiny "suspended" particles specially designed by the chemical composition sandwiched between two glass covered surfaces (see Fig. 4).



**Fig. 4.** Schematic representation of the operation of the SPD "smart" panels.

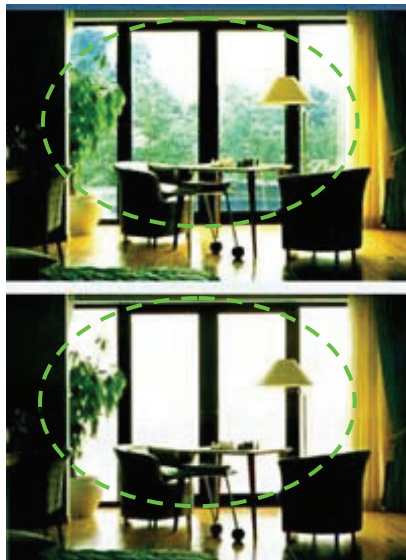
The normal distribution of particles an arbitrary orientation position may block up to 99.75 % of incident lighting through a given area of "panel". When power in the SPD partition panel is on in the conductive layers, the temporarily suspended particles in the layer are oriented in the electrical field and allow the passage of light through the panel. Sensor-controlled voltage can assume infinite number of shades of transparency up to full opacity. Such potential of "smart" panels gives the owner of the facility the possibility to use it at their own discretion and to partition a space by temporarily changing intended use of space and intimacy factor. User space may make render the panel fully opaque in a moment (change time is 1 sec.) and return of full clarity comes after 3 seconds.



**Fig. 5.** Operation of SPD panel "barrier" (on, off).

The number of on and off cycles is virtually unlimited and the power consumption in operation is very small. SPD system does not use electricity when in dimmed state. This system allows the option of programming "on" or "off" times of "transparency" and "opacity" phases of the smart panels, as well as the time of partial dimming of both the entire panel surface, and its parts (segments), altering in this way the room lighting and the manner of its use. Also, this system allows the possibility of time programming on the weekly and monthly basis depending on the nature of the commercial or residential property use.





**Fig. 6.** Practical operation of SPD panel "barrier" (on, off).

Considering the data from 2008 Building Energy Databook, in 2006 the buildings consumed 39% of the total energy needs and 73% of all electricity consumers in the USA [6]. A 2006 California Energy Commission study of electro chromic windows on the estimated lighting energy savings of about 44%, compared to a reference case with no daylighting controls. Also, peak demand reduction of 19% to 26% related to windows cooling loads occurred on clear sunny days [7].

Given the high value of the smart "panel", we can confidently install SPD panels in many different design forms in the functional organization of offices and buildings, for example, a possibility of the confident conversation of an employee (boss, manager, owner, etc...) with a client in the temporary visually "screened" area, momentarily sheltered from the view of other employees. Also it is possible to separate the space for temporary appointments with clients and in space with an originally different purpose (Fig. 5, Fig. 6).

Since this technology can be applied to plastic transparent surfaces, it is possible, in terms of architecture, to design the curved surfaces and arbitrary shape areas for multifunctional uses.

### 3. CONCLUSIONS

The application of "smart" panel as the new "flexible" materials in architecture, design and construction of structures of different types of applications creates the potential to create multi-functional units and space. Since the technology of "smart" panels can be applied to transparent plastic surfaces, it is possible to design curved surfaces to be used for multifunctional areas.

By using these materials in the architecture of commercial and residential building one can reduce the overall building energy consumption, achieving better energy benefits and achieving a higher degree of bioclimatic quality.

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## **PRIMENA "PAMETNIH" STAKLENIH PREGRADA KOD OBJEKATA POSLOVNOG I STAMBENOG KARAKTERA**

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*U radu se razmatra specifičan konceptualan pristup u primeni novih "pametnih" materijala sa fazno promenljivim sopstvenim karakteristikama kao i maksimalne mogućnosti iskorišćenja njihovih performansi s aspekta aplikativnosti u arhitekturu poslovnih i stambenih objekata. Ovim pristupom primene donekle se menja uobičajena tradicionalna praksa u primeni nekih od dosad "klasično" ugrađivanih materijala, odnosno ugrađivih "komponenti" u arhitektonski sklop objekta. Istovremeno, otvara se mogućnost u iskorišćenju nemerljivo boljih performansi ugrađenih novih elemenata u arhitektonskom sklopu, kako pojedinačno, tako i ukupno u odnosu na energetske benefite finalnog sklopa objekta.*

*Primenom novih "pametnih" komponenti, postigao bi se ujedno i ekonomičniji energetske efekat, koji bi se ogledao u faktoru smanjenja ukupne energetske potrebe datog objekta kao i u ostvarenju boljeg bioklimatskog efekta samoodrživosti objekta kako na mikro, tako i na makro planu u odnosu na dosad uobičajene performanse klasično građenih objekata.*

Key words: *nove komponente, transparentna pregrada, specijalno zastakljenje, pametni materijali, promenljiva svojstva, staklena pregrada.*