

# Interaction between Architecture and Environment; Investigating the Flexibility of Residential Houses Using Intelligent Materials

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## Abstract

Today, with the advancement and development of building technologies, we are witnessing the emergence of new materials, including intelligent materials, which have many applications by adapting to the environment for creative designs to create more efficient and cost effective buildings, because they cause flexibility in its construction and provide many solutions to meet a wide range of needs of its inhabitants, so that they can be used to measure and evaluate the changes in the environment of human life and control the issues that lead to a change in the physical environment, in particular the change in the building in which life is in progress. Therefore, the question is: how can smart architecture be used with the use of modern materials? In this paper, which is descriptive-analytic, using library resources and analysis of intelligent materials in implemented case studies, it was concluded that the use of modern and intelligent technologies in buildings can significantly save energy consumption, implementation costs, and also maintenance costs. Therefore, the implemented architecture is able to respond to and adapt to its surrounding environment.

**Keywords:** Technology, Intelligent Materials, Residential Buildings, Adoption to Environment, Energy Saving

## Introduction

There has always been a close relationship between the three human, nature, and architectural aspects of history, which has always been the architecture of the human-environment bridge that guaranteed human survival, but today, the third factor that has been very effective in architecture is causing Technology has been growing ever more. Of course, technology has existed in different periods in a variety of ways, which has now become a contributing factor to the emergence of new challenges. The inhabitants of the building have been constructed so that the sides can enhance and improve everything. Most of it builds or destroys this three-dimensional connection between man, nature and architecture.

All previous research shows that the emphasis on learning from nature and the uniformity of architecture with the surrounding environment has been considered as a benchmark, although it is a great way from letter to practice, but this is one of the current concerns of architects and builders of buildings. Therefore, in recent decades, new technologies and intelligent materials have entered the market using natural elements that have tried to coordinate with the surrounding environment, examples of which can be found in self-healing materials, light control and heat storage glasses and so on, that is, the systems that are using A. It can measure and evaluate the changes around human life and control the issues that lead to a change in the physical environment, especially the change in the buildings in which life is in progress, which today is a smart home for these systems.

Therefore, in some cities of Iran, with increasing population, the growth and diversity of people's demands for work and social activities and life issues such as achieving predictable goals, welfare, changing lifestyles and extending the infrastructure of the buildings, or The

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possibility of utilizing day-to-day technology in life has raised new issues in the operation and management of a building in various fields such as safety, protection, repair and maintenance of equipment and facilities, the provision of optimal services, proper use and optimization of consumption in a variety of energies. Which is flexible in the design of housing, since A solution to meet a wide range of needs of its inhabitants will be needed in today's architecture. So, in this research, which is descriptive-analytic, by studying the library of previous research and examining the sample of smart materials and how it is adapted to the building, is seeking answers to the questions and considering the following objectives?

### *Questions*

What is smart home smart home?

What are the best tools for using in residential buildings?

How can smart materials in modern homes be able to meet the new needs of life?

### *Knowing*

Familiarity with intelligence and related concepts in housing.

Understanding smart materials and their applications in housing.

Investigating design approaches to flexible residential buildings using intelligent materials that can lead to home intelligence.

### *The relationship between man and the environment*

A behavior is a function of the people and the environment, the discussion of the behavior without considering the context of its occurrence is not a complete environment. The concept of the "environment" is wide, the "space around" is the main criterion for environmental definitions. Therefore, any definition, or explanation of the nature of the operation of the environment, must be related to something in the surrounding space.

The personal environment includes individual images of the world (behavioral features) and their beliefs and attitudes (experimental characteristics). He stressed that all the realities of the environment, although existing, but not affecting human beings, are only part of these facts as factors affecting humankind, so addressing the environment as a basis for behavior is not enough, but should be an environment that influences Man is identified. (Lang, 2009)

The architectural form is partly based on its activities, and more precisely on behaviors. These behaviors, since space is being built, will be effective in the quality of space until it is destroyed, to the extent that most human behaviors for creating a space, especially from its end users, are less important than the final product or is not space itself. And all of this material confirms the importance of the impact of the behavior on space. (Ghasemi, 2009) In fact, being built is not the ultimate creation of a space or an architectural effect.

The impact of the environment on public behaviors cannot be described as miracles, because even if an environment is capable of performing a group of behaviors, and individuals also understand this and tend to use it, it does not mean that behavior This will certainly happen, because the occurrence of a behavior depends on a number of factors, but on the other hand, if the environment is lacking, it can be ensured that the expected behaviors will not occur. Therefore, although it cannot be argued that adequate space is sufficient conditions for the occurrence (or deletion) of a behavior, but the minimum conditions for it. If we accept that space is filled with the use of people and the occurrence of behaviors, it can be said that if the way people use space in its design, the evolutionary process of the effect proceeds to the point that is desired and in the course of its impact The user's behavior also has a corrective effect.

### *Smart House*

An intelligent building is defined by the Institute of Intelligent Building Buildings, which provides optimal, cost-effective utilization of several basic elements, structures, systems, services and environmental management. In intelligent building, many of the acts that habitually and deliberately performed by the residents are carried out by intelligent systems, which saves time and cost of manpower, (Gholami & Kemerpashti, 2010). including targets in smart homes:

- 1 - Increase comfort and comfort
2. Reduce energy consumption.

An intelligent building addresses the relationship between access, exposure, security, monitoring, management, telecommunications. Smart homes are rapidly developing to provide comfort and security for users. Intelligent systems today, in addition to providing home-made comfort and security, also help to optimize energy consumption and save time and maintenance costs. (Chan & esteve, 2008)

### *Concept intelligence*

In Persian, intelligence means intelligence, consciousness, intelligence, intellect, understanding and freshness. In terms of words, it is "smart". (Smart) In this sense, sensible intelligence and intelligence are the ability to think quickly in different situations; and with vocabulary. (Longman Dictionary, 2008) So intelligence is a concept that refers to a kind of reaction, a response that is made to different conditions and has a fast pace. Due to the different conditions, there will be a need for different reactions. This means that the type and type of reaction will change according to the circumstances. And the reaction must inevitably have the ability to return to its original state, in order to be prepared to respond to the new conditions (Sinopoli, 2010). Architectural intelligence means that the building is designed and constructed to respond to environmental factors and change the needs of the users after construction.

### **Smart Materials**

The intelligence of controlling systems is evident with many components and complex computer programs, while the intelligence of materials is a different matter and is a component of the material and does not require the programming and / or external controls and complex infrastructure, the material " Intelligent engineering materials that are intelligently responsive to their environments are, in fact, smart materials, are an appropriate response to the needs of 21st Century technology. Smart materials are in the process of discovering new materials. Historically, the discovery of intelligent materials dates back to the 19th century, but at that time there was no modern technology to produce products and human knowledge in order to recognize the needs of the people and to match the new materials with needs, (Addington & Schodeck, 2005)when in In the present era, especially in the last three decades, with the advancement of technology and the promotion of human knowledge, the possibility of developing and expanding these materials in various sciences has been given and their application in the world has become widespread.

NASA intelligent materials are materials that remember the situation and can return to that position with certain stimuli. The Encyclopedia Definition of Chemical Technology is the materials that make sense of the environment and react to the environment by processing this sensory information. The most unique properties of these materials and intelligent technologies are molecular, material, composite or system according to Table 1 (Addington & Schodeck, 2005)

Table 1. Basic Properties of Intelligent Materials

delineation	Features of materials and smart technologies
This means that their response is immediate (simultaneously with the stimulus effect)	Important
They have the power to respond to local conditions.	adaptability
Intelligence is within these materials, not outside them (meaning that they do not require a computer program and complex systems of controller and operator)	Self-motivation
Their response is distinct and predictable	Selectivity
The responses are triggered in one place	Direct communication

### *Application of intelligent materials in the building*

#### *Smart reaction temperature reactors*

These materials react in a reversible environment around the ambient temperature and are in a smart material group with the ability to change internal properties. This category of materials includes a variety of varieties, with a limited number of them used in architecture. Such as expanding materials that have a thermal expansion coefficient. Their most important application in architecture is to control and manage energy in buildings in the construction of heating thermostats. Therefore, as a special stimulus in greenhouses, the room ventilation system and building services are used (Figure 1).

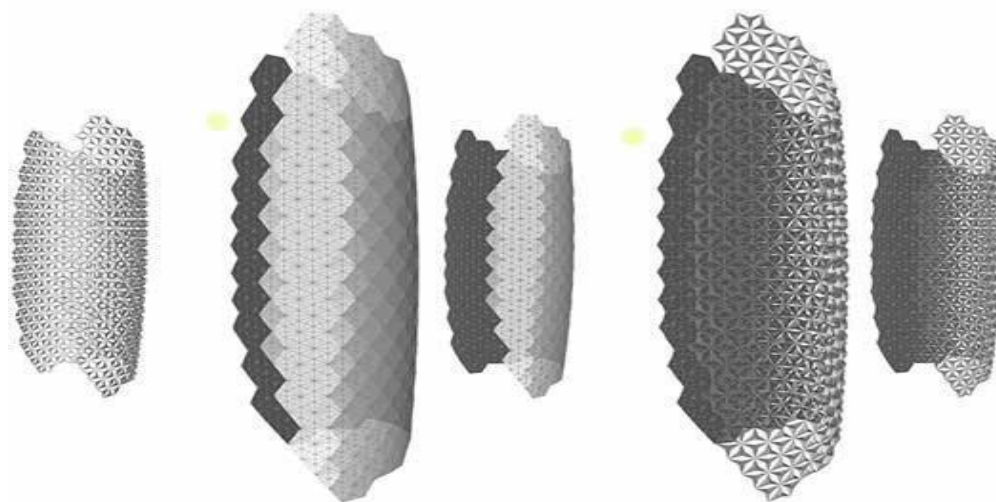


**Fig. 1.** Smart window

Twin Towers Al-Bahar completed at 145 meters high with 29 floors in the United Arab Emirates's capital Abu Dhabi in 2012. The characteristic feature of these towers is the skin consisting of 2,000 umbrella umbilical's that open and close in response to the intensity of sunlight. The design of this tower has been made by AEDAS ARCHITECTS, and has been built by the Al-Fitum Group(Figures 2 & 3)



**Fig. 2.** Tower of the Twin Sqa al-Bahr in Abu Dhabi



**Fig. 3.** Intelligent system used in Al-Bahar Twin Towers

### *Smart Energy Saver Materials*

These materials store energy in the form of light, heat, hydrogen, or electricity. Intelligent heat storage materials in this group are more noteworthy. These materials have an inherent property that enables them to store energy in the form of heat or cold as a substitute energy. The most commonly used ones are in the subgroup of variable controller materials that can act as a medium for setting the temperature. They changed their state from liquid to solid by crystallization and released a certain amount of heat energy they had previously stored at higher temperatures, and in reverse state, changing from solid to liquid at the time of energy entry Heat the temperature to maintain a constant heat or temperature. An example of this is the Swiss retirement housing, which the Swiss architect uses in hydrates to store salt as PMC materials (salt water at 26-28 degrees Celsius) The architect designed a new design of an insulating and storage glass system filled with salt hydrates and installed it in the southern view of the complex at an area of about 148 square meters. (Figure 4)



**Fig. 4-**Pension retirement project in Switzerland

### *Reflects light intelligent materials*

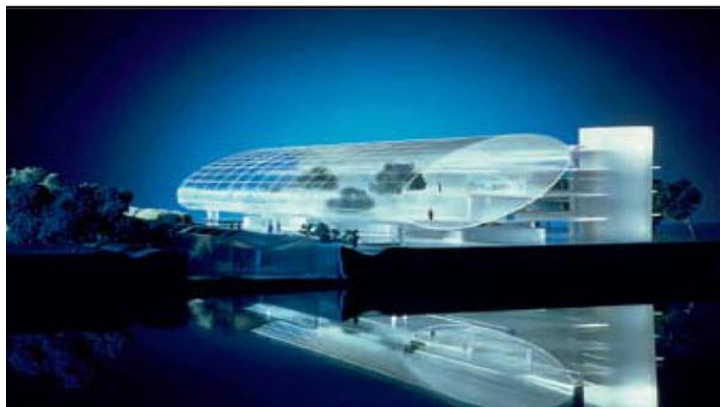
The molecules inside them are excited by the effects of light or electric energy, and emit light. The most important and most used architectural materials are photolumines and electrolysis. This phenomenon is a temporary condition for molecules that occur in high energy. As part of the energy absorbed by the molecules emits a visible electromagnetic radiation. (Figure 5)



**Fig. 5 -** Photolumines for emitting light

### *Change the Intelligent Materials*

These materials are capable of reversing their color or visual properties in response to one or more external triggers. Three categories of these materials, including photochemical, thermochemical and electrochemical materials, are highly regarded in architectural applications. One of the first projects in which photochemical materials were used in building envelopes. One can name the entrance to the Museum of Modern Art in Munich, which two German architects used in the 1992 race. Since then, the use of these materials has been made in architecture and in the field of monuments. (Figure 6)



**Fig. 6-** Munich Museum of Modern Art

The application of electrochemical materials is also in the electrostatic glass architecture. Electro-apical materials change the visibility of their exposure to solar radiation, their transparency. At the moment, the world's largest electrospinning coating has been used in a building facade in Tokyo in 2004. (Fig. 7). The facade of this project consists of several functional layers, the outer wall of which is of a kind of gray glass, which makes it look beautiful and beautiful by connecting to the stainless steel frame and the honeycomb loose structure. The next stratum is a layer of free space, followed by an electrically adjustable electrodeposition layer, and finally an internal structure made up of a glass type with a safety layer on both sides and a horizontal aluminum rail running through it. There are two rows of white lamps placed on them. In this system, during the day, the electro-optic glasses, followed by the entire face, are translucent. The view that is created inside the building is unthinkable. During the night, the glass has a blurry look and a facade of a cover, like a cinema screen.



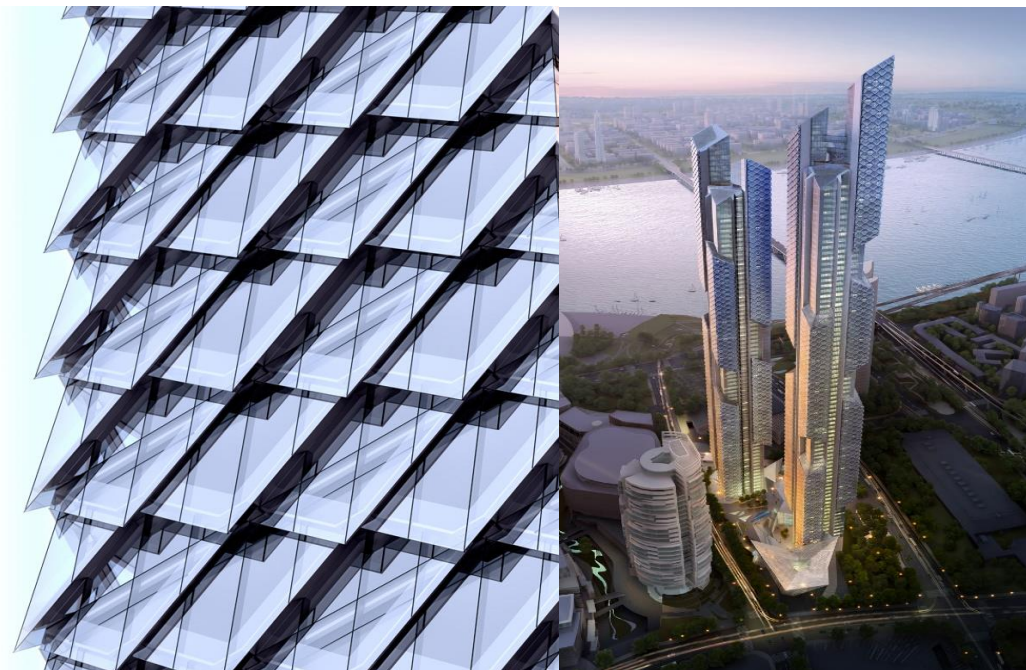
**Fig. 7-** Chanel Central Office in Tokyo

#### *Intelligent materials with the ability to change internal materials*

The materials have recyclable materials that contain or release substances in the form of molecules in the form of gas, liquid or solid, with various physical or chemical processes. The performance of this material is such that it reacts with a variety of gas, water vapor, water or even juicy solutions. Mainly used in the external or internal facade of the buildings, and the most famous of them are materials that are themselves clean. Also, in the form of coatings and layers on the surface of the building, the pollutants in the air are ineffective and destroyed. One of the most important applications in the architecture is the waterproofing of the facade, the cleaning of the facade, raising the air quality of the interior, eliminating the pollution of the surrounding air, absorbing sound, and creating a fragrant smell in space.

The smartest materials known as self-cleaning materials are titanium dioxide. This substance is exposed to ultraviolet rays of sunlight into a highly active and reactive substance that prevents bacteria and dirt from sticking to walls and buildings and results in easy cleaning by rain water. Self-erected materials are the most practical materials in urban design that can help clean up large cities and reduce air pollution.

The design of dragon towers in Seoul (South Korea) is one of the newest modern architectural projects in the country. These two skyscrapers have been created with almost identical designs. The tallest tower is 450 meters high. The properties of this design can be pointed to smart glasses that play a significant role in reducing the cost of cleaning and controlling the environment by adjusting the light inside the interior and removing dust. (Figure 6)



**Fig. 8-Twin Dragon Dance Tower in Seoul**

## Conclusion

The environment will not always be able to respond to the behaviors of users within structures with a variety of functions, even if the environment is capable of performing a group of behaviors, and individuals also understand this and want to use it in this sense. Not that the behavior would happen because the occurrence of a behavior depends on a number of factors, therefore, the application of technology that is in line with the interaction between the environment and the architecture within which life is in progress, therefore, since intelligent materials They have almost invincible power, they can change in response to their surroundings that natural materials (non-intelligent).

They are capable of a positive development in architecture, construction, and methodology As they are mentioned in the examples mentioned in this research, smart materials can, according to the instructions they receive from their surroundings, paint They change electricity or produce electricity during the day Or, using a reaction that shows that they are polluting the air around them, have self-healing properties, among which is the importance of using the materials discussed in this research directly And indirectly receive the energy they need from the surrounding environment, therefore, the use of modern and intelligent technologies in buildings can significantly reduce energy consumption, operating costs and maintenance costs, thus saving In this case, the architecture is able to respond to its surroundings and with Be compatible.

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