New Design Ideas
Vol.7, No.3, 2023, pp.607-611

POSSIBILITIES OF USING PEROVSKITE STRUCTURE IN MODERN ARCHITECTURE AND CARPET WEAVING

S.H. Jabarov[1*], Y.I. Aliyev[2]

[1]Institute of Physics Ministry of Science and Education of Azerbaijan, Baku, Azerbaijan
[2]Azerbaijan State Pedagogical University, Baku, Azerbaijan

Abstract. In this study, the design features of the perovskite structure were investigated. This structure was analyzed in terms of both appearance and quality factor. It has been established that an interesting pattern can be observed when considering the perovskite structure from different planes. On the other hand, the connections in this design are organized in such a way that the assembled structures can have high strength. Thus, the structure of perovskite corresponds to a crystal structure with high symmetry, and this structure is resistant to pressure and temperature. Therefore, its application in modern construction is shown.

Keywords: *perovskite, construction, art, carpet.*

Corresponding Author: *S.H. Jabarov, Institute of Physics Ministry of Science and Education of Azerbaijan, Baku, AZ-1143, Azerbaijan, e-mail: sakin@jinr.ru*

Received: *23 June 2023;* ***Accepted****: 7 November 2023;* ***Published:*** *8 December 2023.*

1. Introduction

It is known that symmetry exists in the structures of solids with a crystalline structure. With an increase in symmetry, the resistance of these crystals to external influences also increases. Therefore, obtaining compounds with high symmetry is one of the main problems not only in crystallography, but also in materials science. Symmetry is important not only in crystal structures, but also in many areas and in nature. Patterns used in art and architecture maintain symmetry. Therefore, the structures observed in crystals can be used in patterns (Hargittai, 2007; Mamedov, 1986; Hargittai, 2007).

Recently, many architectural monuments use special building materials. Constructions resistant to high pressures are tried to be obtained by various methods (Wang *et al.*, 2015). Crystal structures with high symmetry are very resistant to pressure (Michael Brown, 1999). Therefore, these structures can be used in construction.

It is known that many of the properties observed in crystals are used in art. With the help of structures, you can get various works of art (Holzapfel, 2014). It has been established that when using crystallographic structures on carpets, various patterns can be obtained. These patterns were used in carpet weaving in the XIV-XVIII centuries (Necefoglu, 2003).

In this work, the perovskite crystal structure was studied and its design was constructed on different planes. The possibilities of applying the obtained images in architecture are shown. It has been established that it can be applied in modern

How to cite (APA):
Jabarov, S.H., Aliyev, Y.I. (2023). Possibilities of using perovskite structure in modern architecture and carpet weaving. *New Design Ideas, 7*(3), 607-611.

architecture both in terms of mechanical strength and visual appearance. This structure is shown to be used for patterns on carpets.

2. Perovskite structure

This structure was first discovered in 1839 in a $CaTiO_3$ crystal. Oxidation is known to occur in non-oxide materials (Kay & Bailey, 1957). Therefore, oxides are more stable than other structures. But the reason for the stability of this structure is not only in oxygen. Because this structure has a high symmetry. The crystal structure of the $CaTiO_3$ mineral and perovskite is shown in Figure 1.

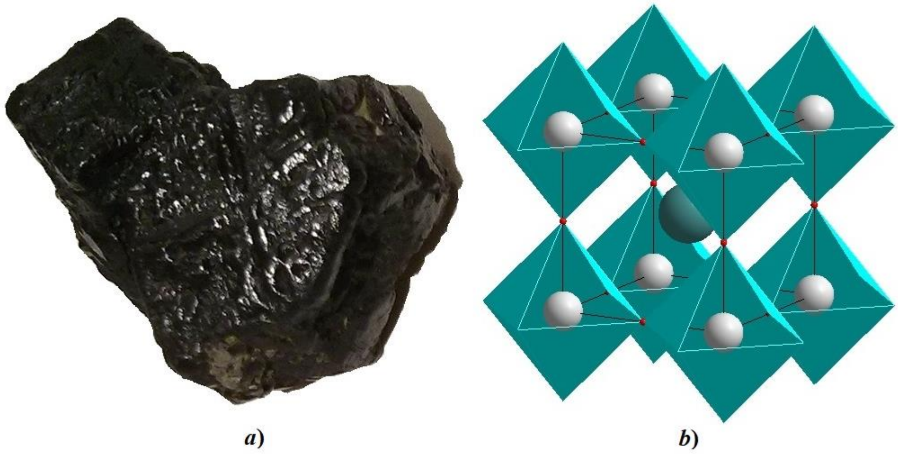


Fig. 1. The mineral perovskite (*a*) and the crystal structure of perovskite (*b*)

As can be seen from Figure 1, the highly symmetrical crystal structure observed in the crystal structure is also observed in the appearance of the mineral. It has been established that the crystal structure of perovskite consists of the chemical form ABO_3, which is formed by various *A* and *B* metal atoms with O - oxygen atoms. *A* - metal atoms are in the center of the crystal lattice. *B* - metal atoms are at the nodes of the cell. Oxygen atoms combine with metal atoms throughout the cell, forming covalent bonds (Jabarov *et al.*, 2021). Let's take a look at the applications in architecture and carpet weaving using the strength and appearance of this crystal structure.

3. Application possibilities of perovskite structure

3.1. Application in architecture

The perovskite structure can be used in architecture in two ways. It is known that the main purpose of building construction is the mechanical strength of the building. On the other hand, each built building must have a certain architectural style. Considering each of these factors, the perovskite structure can be used in construction. In figure 2(*a*) shows interatomic bonds in the perovskite crystal structure. As can be seen from the figure, the main bonds are formed between the metal atom standing in the center of the crystal lattice and the oxygen atoms standing around it, which leads to high symmetry in the crystal structure. The metal atoms in the nodes of the cell are at a minimum distance. The close arrangement of atoms in this structure and, consequently, strong interatomic bonds make it possible to use it in construction. In figure 2(*b*) shows the structure of the building. As you can see in the photo, they try to keep maximum strength with concrete-metal structures. So they both place concrete pillars close together and connect them to each other. In this design, the atoms at the nodes of the cell can be used in the perovskite structure. For parts with stairs between floors of a building, you can also use the position of the metal atom in the center of the perovskite structure.

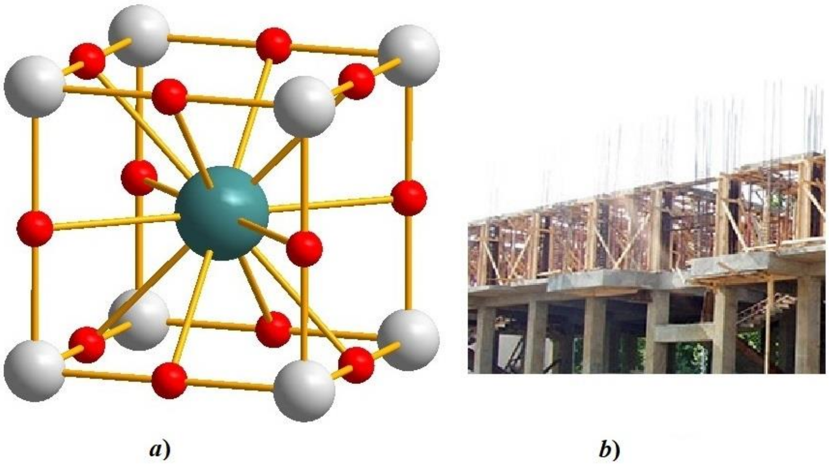


Fig. 2. Atomic bonds in the structure of perovskite (*a*) and building structure (*b*)

For the above reasons, the perovskite structure appears to have a wide range of applications in modern construction. At the same time, it is necessary to analyze the structure of perovskite in terms of design. In fig. 3 shows a comparison of a building built in a crystal structure and a perovskite structure.

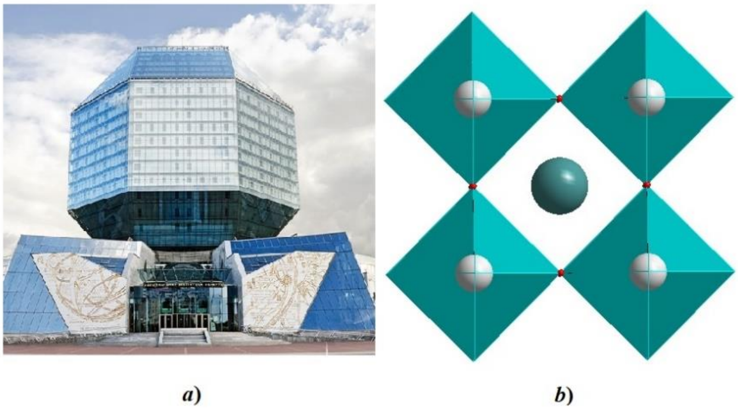
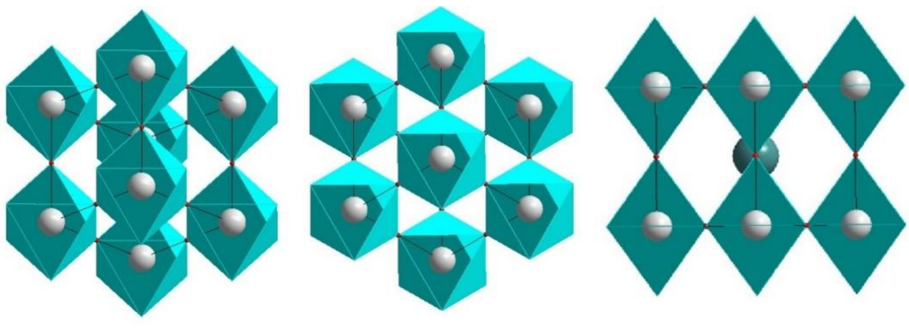


Fig. 3. The building of the National Library of Belarus (*a*) and the perovskite structure on the $\vec{a}\vec{b}$ plane

In figure 3(*a*) shows an image of the National Library of Belarus in Minsk. As you can see in the picture, the library building is built in the form of a crystal. This view gives a special beauty to the building and is made in a beautiful design. In figure 3(*b*) shows the design of the perovskite structure in the $\vec{a}\vec{b}$ planes. It can be seen from the figure that this design can be used in two ways in the architectural style. The first form is to construct the building in the perovskite structure as a whole, and the second form is to construct the floors in the perovskite structure.

3.2. Application in patterns

When analyzing the possibility of using a perovskite structure in an architectural style, it became clear that this structure is a suitable example both in terms of strength and design. Since it is convenient in terms of design, this model can also be used in carpet weaving. From the drawing of the perovskite structure on the $\vec{a}\vec{b}$ planes in figure 3(*b*) shows that this shape differs from the general view shown in figure 1(*b*). Therefore, images of the perovskite structure were obtained at different angles (Figure 4 *a*,*b*,*c*).



a) b) c)

Fig. 4. Perovskite structure in different planes

From the designs shown in Figure 4, it can be seen that these types differ in design. The presence of high symmetry in the perovskite structure results in a very symmetrical, pleasing design when viewed from any plane. The use of these shapes on carpets can lead to the creation of new patterns. In figure 1(*a*) shows a carpet. As seen in the carpet, the outer patterns not only define the borders of the carpet, but also create the symmetry of the carpet. Large patterns inside the carpet not only stand in the center, but also complete the design. In figure 5(*b*) shows the possibility of using the perovskite structure in the outer patterns and the central patterns of the carpet.

a) b)

Fig. 5. Carpet (*a*) and perovskite pattern (*b*)

The optimal figures were selected for the use of the perovskite structure in the outer patterns of the carpet and in the central patterns (Figure 5(*b*)). As you can see, there are opportunities to use patterns taken from different angles. Especially the patterns on the edges of the carpet can be used in a modern design style.

4. Conclusion

The design possibilities of the perovskite crystal structure have been studied. It is determined that this structure can be used in modern architectural style and in the production of carpets. The possibilities of using perovskite structures obtained on different planes are studied, and the areas of their application are indicated. It is noted that the high symmetry of this design expands the scope, both in terms of strength and design. To apply the obtained images in different planes, comparisons were made with their counterparts in construction and carpets.

References

Hargittai, M. (2007). Symmetry, crystallography, and art. *Applied Physics A*, 89, 889-898.

Mamedov, Kh.S. (1986). Crystallographic patterns. *Computers & Mathematics with Applications*, 12, 511-529.

Hargittai, I. (2007). Crystal structures and culture: In memoriam Khudu Mamedov (1927–1988). *Structural Chemistry*, 18, 535-536.

Wang, Z., Gao, Z., Wang, Y., Cao, Y., Wang, G., Liu, B. & Wang, Z. (2015). A new dynamic testing method for elastic, shear modulus and Poisson's ratio of concrete. *Construction and Building Materials*, 100, 129-135.

Michael Brown, J. (1999). The NaCl pressure standard. *Journal of Applied Physics*, 86, 5801.

Holzapfel, W.B. (2014). Structures of the elements - crystallography and art. *Acta Crystallographica Section B: Structural Science, Crystal Engineering and Materials*, B70, 1-7.

Necefoglu, H. (2003). Crystallographic patterns in nature and Turkish art. *Crystal Engineering*, 6, 153-166.

Kay, H.F., Bailey, P.C. (1957). Structure and properties of $CaTiO_3$. *Acta Crystallographica*, 10, 219-226.

Jabarov, S.H., Aliyev, R.T. & Ismayilova, N.A. (2021). Probabilistic model of structural phase transition in perovskites. *Modern Physics Letters B*, *35*(12), 2150211.