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Role of Ferroelectric Ceramic Materials Based on Nano-Particles in the Production of Antique Art

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Abstract: Nanomaterials refer to materials that have at least one dimension in the nanometer level in the three-dimensional space, the size of which is (0.1-100nm), or is composed of these basic unit types, which is probably 10-100 A is derived from the size of the arrangement; a nanoparticle is a kind of artificially manufactured micro-particles with a size of no more than 100 nanometers. Its form may be latex, polymer, ceramic particles and carbon particles, and is widely used in medicine, sunscreen cosmetics, etc. This article aims to study the role of nano-particle preparation of ferroelectric ceramic materials in the production of antique art, mainly from the doping modification and ferroelectric materials to conduct experiments and explorations, and explore the impact of materials on the finished product. Through performance testing and characterization of a series of samples, it is concluded that the Curie temperature of the best-performing BaTiO3 ferroelectric ceramic material increases, the grain size decreases. The ferroelectricity gradually increases, and the density increases. And proposed that it can be sintered into porcelain under low temperature conditions, and the density and dielectric properties of the obtained ceramic are the best, and it is compounded with a ferroelectric with a low Curie temperature to achieve the purpose of broadening the Curie peak. The experimental results in this paper show that when the environment is above the Curie temperature of 110℃, the material exhibits paraelectric characteristics, when it is less than this temperature, the ferroelectric characteristics appear. When the operating temperature is about 100, the heating rate is still slower, about every time the temperature rises by 1.5 degrees per minute. This process is conducive to the increase of moisture in the equipment and can reduce the cracking caused by drying; when the temperature is about 500, the temperature rises about 3 degrees per minute. This process helps the oxidation and decomposition of the forming agent. When the temperature is around 900 degrees, the temperature rises about 5 degrees per minute.

1. Introduction

1.1. Background

Ferroelectric ceramics are ceramic materials whose main crystals are ferroelectrics. Under a certain environment, the temperature will spontaneously polarize, but when the temperature exceeds a certain range, it will disappear spontaneously. From the production of TVs in the late 1980s to the rise of various electronic products today, the entire electronics industry has achieved tremendous development, and ceramic materials play a pivotal role in it. With the rise of the electronics industry, related both the equipment industry and the material industry have ushered in their own development. Ferroelectric ceramic materials have the characteristics of high dielectric number and low loss, and have been widely used in various industries. At present, the production of many artworks has great limitations. Taking ceramic production as an example, it is easy to cause various defects such as chromatic aberration, interlayer, deformation and cracking during the production process. The main reason for this part is the production material. In order to improve the product integrity rate, it is urgent to find new alternative materials. In recent years, ferroelectric ceramic materials have become the darling of materials, and it has become a wise move to combine ferroelectric ceramic materials with contemporary antique art.

1.2. Significance

Ferroelectric ceramics have a variety of advantages, which have greatly promoted various industries. Aiming at the development of ferroelectric ceramic materials, this article has improved the utilization rate of ferroelectric ceramic materials, expanded the scope of application, and at the same time improved the production level of the antique industry and improved the production level.

1.3. Related Work

Ferroelectric ceramic materials have been widely used in related fields, driving their application in other fields and the current production of antique art has certain limitations in finished products. Researchers believe that ferroelectric ceramic materials can be applied to antiques and other art works. In terms of production, improve the intact rate. Subramanian V studied the effects of AuO and au (III) on interface holes transfer, and synthesized gold-terminated TiO2 nanocomposite particles by reducing [AuCl4] on the surface of pre-formed TiO2 colloids in acetonitrile. This semiconductor metal nanocomposite material is considered to be beneficial to improve the efficiency of the photocatalytic oxidation process. The photo-generated holes can oxidize the pre-existing gold layer on the TiO2 particles in the aerated solution. The experimental conditions for the photocatalysis experiment determine the semiconductor/metal interface. The net concentration of metals and metal ion species determines the overall catalytic activity [1]. Li J conducted a study to demonstrate the energy storage in ferroelectric polymer nanocomposites, which contain surface-functionalized BaTiO3 nanoparticles. The research aims to integrate complementary elements, such as the high dielectric constant of inorganic dopants and the high breakdown strength of the polymer matrix, to significantly increase the energy density. It also proved that the average energy density from each composition needs to be implemented to achieve high energy density. It was found that the presence of an organic surface layer on the particles provides better compatibility between the filler and the polymer matrix, ensuring a uniform composite film at a higher filler concentration. The study also proved the leading role of the dielectric constant of the polymer matrix in determining the energy density of the nanocomposite[2]. Sheng Z reported the simple synthesis of carbon-supported PtAu alloy nanoparticles with high electrocatalytic activity as the anode catalyst for direct formic acid fuel cells (DFAFC). PtAu alloy nanoparticles were prepared by co-reducing HAuCl4 and H2PtCl6 with NaBH4 in the presence of sodium citrate, and then deposited on Vulcan XC-72R carbon support (PtAu/C). The obtained catalyst was characterized by X-ray diffraction (XRD) and transmission electron microscopy (TEM), which showed that PtAu alloy nanoparticles with an average diameter of 4.6 nm were formed. Electrochemical measurements show that the catalytic activity of PtAu/C for formic acid oxidation is 7 times that of Pt/C. This significantly enhanced activity of the PtAu/C catalyst can be attributed to the formation of discrete Pt sites in the presence of adjacent Au sites, which promotes the direct oxidation of formic acid [3]. Ma W proposed that the antiferroelectric (AFE) AgNbO3 (AN can be used to partially replace the relaxation ferroelectric 0.76Bi0.5Na0.5TiO3–0.24SrTiO3(BNT–ST) in the same phase boundary (MPB) composition to reduce Residual polarization, while maintaining a large maximum polarization. In this way, BNT-ST-5AN ceramics obtain a large recoverable energy storage density (2.03 J cm-3) under a low electric field of 120 kV cm-1), better than other lead-free energy storage materials under similar electric fields. In addition, it also achieves excellent temperature (25–175 ℃) and frequency (1–100 Hz) stability[4]. Singh J proposed ceramic material enhancement the wear behavior of aluminum composite materials, the influence of mechanical parameters such as applied load, sliding speed, sliding distance, temperature, mating surface hardness, etc.; and the material factors that affect the wear resistance of aluminum composite materials, such as the type, size, shape and the scores are reviewed and discussed. It has been shown that these parameters will affect the surface and subsurface behavior of aluminum composites under sliding wear conditions. In addition, it has also been observed that ceramic reinforcement improves the performance of aluminum composites under double-body wear or adhesion wear. However, due to the three-body abrasive wear, the wear resistance of these composites under medium load conditions is similar to that of the matrix alloy. At the same time, it is considered that the use of solid lubricant (Gr) particles and hard ceramic particles (SiC or oxide) Aluminum) can be effectively improved as a hybrid reinforcement material [5]. Elsaka evaluated four different surface treatment methods on the shear bond strength (SBS) of ceramics and metal brackets and Vita Enamic (VE) CAD/CAM hybrid ceramics. Influence A total of 240 plates (10mm×10mm×3mm) were cut from the VE ceramic block and divided into two groups. In each group, four subgroups were prepared from hydrofluoric acid (HF); phosphoric acid (H3PO4); Diamond ceramic grinding head; and the use of CoJet system (CJ) silica coating. Maxillary central incisor metal (Victory series) and ceramic (Clarity) brackets are bonded with light-curing composite materials, and then stored in artificial saliva Thermal cycle for 1 week. SBS test was performed, and the failure types were classified according to the residual glue index score. After processing, the surface morphology of the ceramic was characterized by scanning electron microscope. Two-way analysis of variance, Tukey HSD test and Weibull analysis were used the data was analyzed. At the same time, it was found that SBS was significantly affected by the type of bracket and the type of treatment [6]. Garcia-Giron A reported the results obtained by liquid-assisted laser ablation of advanced ceramics and glass ceramic materials. The basic wavelength is 1064nm, AQ-switched Nd:YAG laser with a pulse width in the nanosecond range was used to process the material, and the material was immersed in water and glycol. The changes in geometric parameters, morphology and ablation yield were studied by using the same laser working conditions. According to observations, the processing depth and the amount of removal depend on the thermal, optical and mechanical properties of the processed material, as well as the properties of the surrounding medium for laser processing. According to the function of the liquid used to assist laser processing and the changes in the ablation yield related to the refractive index and viscosity, it was found that the material characteristics and working conditions are also related to the results obtained [7]. Fragassa C studied how to model the viscoelastic response of ceramic materials through a commercial finite element code, which allows ceramic tiles to bend without further intervention: gravity is used only in so-called thermoplastic deformation. General viscoelastic response and especially thermoplastic deformation are complex aspects of material behavior that need to be accurately modeled. Generally speaking, viscoelastic theory can be considered to be very large and accurate, but its application in practical cases is very difficult. Time related problems, like viscoelasticity, must be combined with temperature related situations. This means that even if the constitutive equations can be set as general formulas, all the basic parameters in these formulas will change in the functions of the two entities. The finite element code can help bypass this deadlock and allow discrete temperature changes [8]. Although these theories have carried out certain research on the production of nanoparticles, ferroelectric materials and ceramics to a certain extent, the combination of the two is relatively small and the practicality is insufficient.

1.4. Innovation

The composite nanoparticle material produced during the experiment has a small particle size and a relatively uniform distribution; the time is shorter and the efficiency is higher in the process of manufacturing the finished product, whether it is the use of raw materials or the manufacturing of the product, it has been successfully achieved It is pollution-free and conforms to the green environmental protection concept advocated by the current society.

2. Ferroelectric Ceramic Materials Based on Nano-Particles in the Production of Antique Art

2.1. Nanomaterials

Nanomaterials are materials with nanoscale structures. According to their specific dimensions, they can be divided into zero-dimensional nanomaterials and one-dimensional nanomaterials. It has been asserted that when people can arrange and combine on substances of very small sizes, they will obtain a variety of Novelty material [9]. Until the end of the last century, the first International Nano Science and Technology Conference was held in the United States, which officially combined theoretical research with contemporary science and technology, which marked the official birth of nanotechnology. When the size of the material is at the nanometer level, the number of atoms on the surface of the material will increase drastically, and this number will far exceed the number of ordinary materials. At this time, the chemical activity of the material will greatly increase. At the same time, nanomaterials are equivalent to or smaller than the wavelength of light, de Broglie wavelength and the coherence length of the superconducting state, and the periodic boundary of the material is destroyed, resulting in "novel" optical, electrical, magnetic, acoustic and thermodynamic properties; In addition, nanomaterials also have quantum size effect and macroscopic quantum tunneling effect [10-11]. These unique characteristics provide conditions for the wide-range application of nanomaterials. With the continuous in-depth development of theory and practice, nanostructures that are not called systems have now been established. As the application matures, the uniqueness of nanomaterials plays a pivotal role in the fields of biotechnology and advanced manufacturing. Figure 1 is a schematic diagram of common nanomaterials:

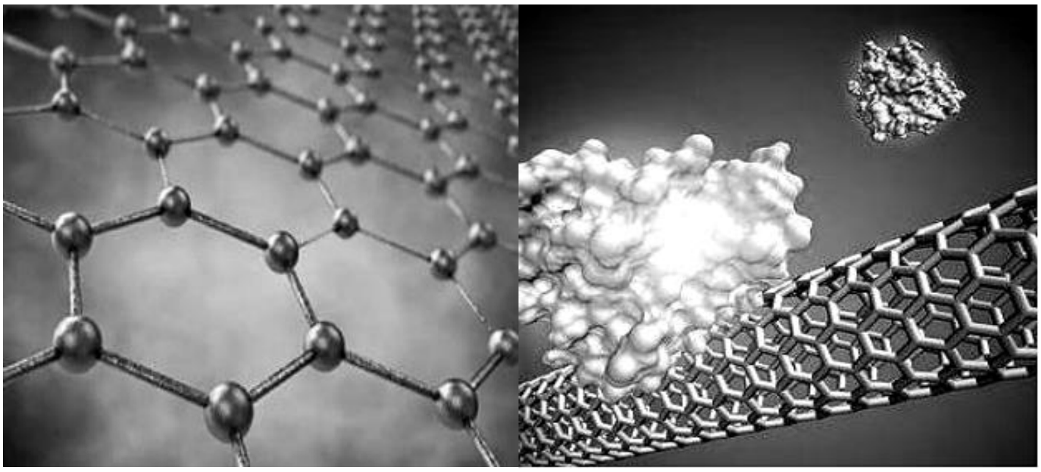

Figure 1. Schematic diagram of common nanomaterials

Nanomaterials have attracted attention as potential dielectric materials, and most of the current research on this material has focused on the influence of nanoceramics doping degree on the dielectric properties of ceramics. In the traditional production process, the oxide is usually covered on the ceramic surface by chemical means. This method can reduce the loss and increase the energy storage density. However, because the oxide is a non-ferroelectric body, it belongs to the ferroelectricity of the ceramic itself. Physical performance will be disturbed [12]. In order to satisfy the use of nanomaterials in national defense and communications, we usually add dopants to the original materials to change their defects. This method has good effects and has been widely used in the storage field. In use, it is found that when the dopant material reaches a certain limit, the dielectric and ferroelectric properties of the ceramic will show a relaxation ferroelectric phenomenon.The application of nano-ceramic materials on capacitors requires a stable dielectric temperature [13]. This can be achieved by adding rare earth elements. This method can inhibit the growth of crystal grains and can also obtain dense fine powder. Figure 2 shows the image of the nano powder. This material can be fired into high-density ceramics. Figure 3 is a schematic diagram of the ceramic firing process:

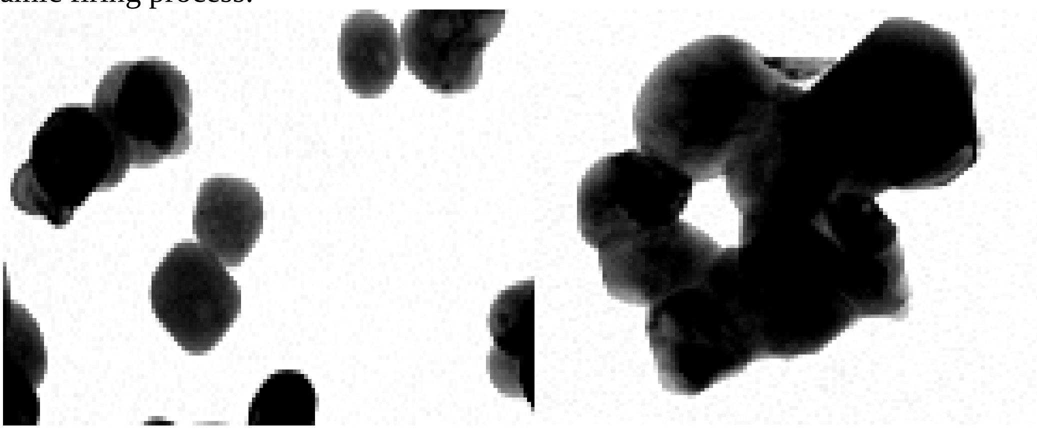

Figure 2. Nano powder image

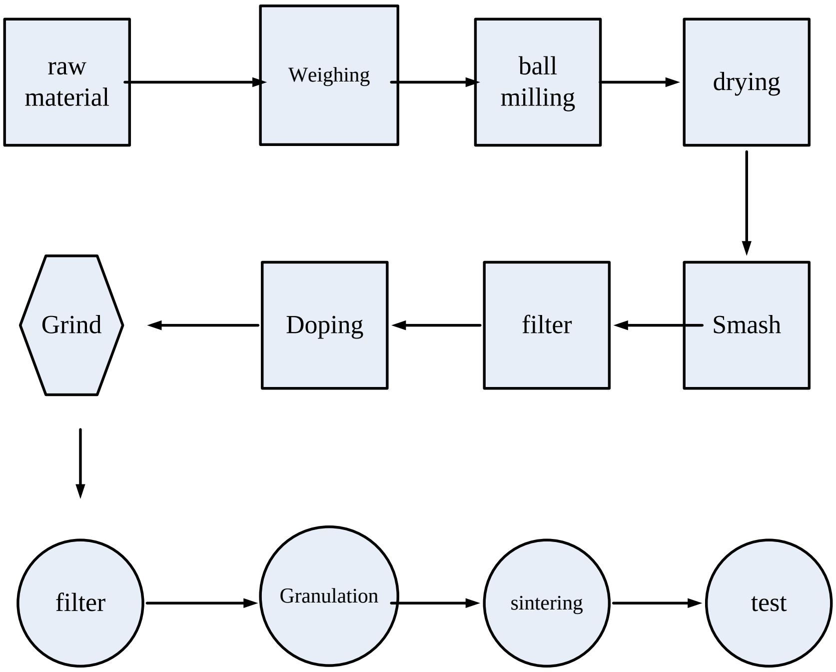

Figure 3. Ceramic firing process

2.2. Material Preparation

In material research, AC impedance spectroscopy is widely used, especially in nano-ceramic materials, we can get the internal grain resistance and grain boundary resistance through testing, according to its intrinsic properties [14]. The complex impedance of ceramics can be expressed by the following functional expression:

$$Q = T_a + \left(\frac{1}{T_{ab}} + yuW_{ab}\right)^{-1} \tag{1}$$

The above expression contains two parts, the real part and the imaginary part, which can be expressed as follows:

$$Q_1 = T_a + \frac{T_{ab}}{1+\left(uT_{ab}W_{ab}\right)^2} \tag{2}$$

$$Q_2 = \frac{uT_{ab}{}^2 W_{ab}}{1+\left(uT_{ab}W_{ab}\right)^2} \tag{3}$$

Combine the two function expressions, you can get:

$$\left(Q_1 - T_a - \frac{T_{ab}}{2}\right)^2 + Q_2^2 = \left(\frac{T_{ab}}{2}\right)^2 \tag{4}$$

In the above, T represents the center of the circle and the radius is ${}^{T}\!/_{2}$. The intercept at the high frequency end is T_a, and the intercept at the low frequency end is T_{ab}.

The relationship between the height of the potential barrier and the resistance during the test can be expressed as follows:

$$\beta = \beta_0 \exp\left(\frac{\alpha\eta}{fT}\right) \tag{5}$$

Among them, β stands for resistance, α stands for electric charge, η stands for potential barrier height, β_0 stands for constant, f stands for Boltzmann constant, and T stands for Kelvin temperature.

$$\eta = \frac{\alpha M^2}{8\lambda_0 \lambda M_d} \tag{6}$$

Among them, λ represents the relative permittivity, and λ_0 represents the vacuum permittivity. According to the above functional formula, we can get:

$$\beta = \beta_0 \exp\left(\frac{\alpha^2 M^2}{8\lambda_0 \lambda MfT}\right) \tag{7}$$

In this process, dielectric constant can be used instead of relative dielectric constant. At this time, you can get:

$$\lambda_1 = \frac{\lambda u}{2l} + \gamma 2\beta \tag{8}$$

Among them, u represents the average grain size of the ceramic sample, and l represents the thickness of the depletion layer. At this time, the dielectric constant is obtained from its capacitance and appearance, which is expressed as follows:

$$\lambda_1 = \frac{Ps}{\lambda A} + \lambda^{0.5} \tag{9}$$

In the above expression, P represents the sample capacitance, which will change with temperature, s represents the thickness of the sample, and A represents the area of the electrode coated by the sample. After simplifying the function expression, we can get:

$$\beta = \beta_0 \exp\left(\frac{\alpha^2 M\eta}{8\lambda_0 \lambda_1 fT}\right) \tag{10}$$

Take a sample from the ceramic to be tested and test it. The water absorption, volume and pores of the material are as follows:

$$Q_1 = \frac{l_3 - l_1}{l_1} * 100\% \tag{11}$$

$$E_1 = \frac{l_3 - l_1}{l_3 - l_2} * 100\% \tag{12}$$

$$K_1 = \frac{l_1 * K_D}{l_3 - l_2} * 100\% \tag{13}$$

Among them, Q_1 represents the water absorption rate, E_1 represents the porosity, K_1 represents the volume density, and K_D represents the liquid density at the test temperature.

$$F = \frac{Rd_2}{a} * \frac{l_1 - l_3}{l_2} * 100\% \tag{14}$$

Among them, R represents the breaking load, d_2 is the distance between the two supporting rods, expressed in mm, and a represents the width.

$$W = \frac{3Rd^2}{2aj^2} = \frac{3F}{2j^2} \tag{15}$$

In the function expression, R represents the failure load, d_2 is the distance between the two support rods, a represents the width, and j is the thickness of the fracture after the experiment, expressed in mm.

$$\mu_{ab} = \frac{(l_i - l_x) * 1000}{T} \tag{16}$$

Among them, μ_{ab} represents the bulk density, l_i represents the total weight of the ceramsite and pottery cylinder, l_x represents the weight of the graduated cylinder, and T represents the volume.

$$\mu_{sb} = \frac{l * 1000}{T_i - T_x - 500} \tag{17}$$

Among them, μ_{sb} represents the apparent density of ceramsite, l is the mass of ceramsite, T_i is the volume of water and ceramsite, and T_x is the volume of water.

$$\theta_c = \frac{l_2 - l_1}{l_1} * 100 \tag{18}$$

θ_c represents the hourly water absorption, l_2 is the quality of the golden tax style, and l_1 is the quality of the drying style.

$$W = \frac{2.8 * Y_I}{\pi N^2} \tag{19}$$

In the above formula, W represents the strength of ceramsite, Y_I represents the breaking load of a single ceramsite, and X represents the diameter of the ceramsite.

The whole calculation of ceramic products is shown above, and the whole production process is shown in Figure 4:

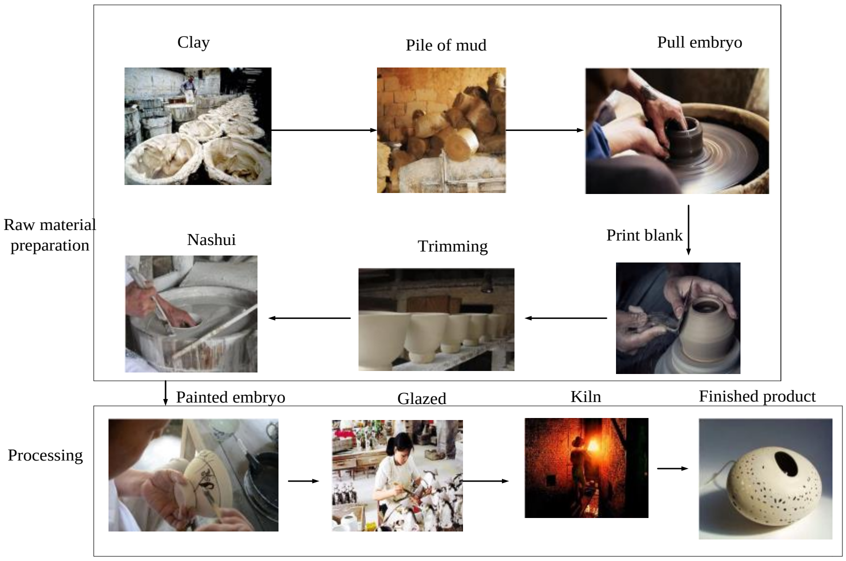

Figure 4. Ceramic production process

2.3. Antique Art

In the contemporary era of continuous economic development, culture has increasingly become a source of national cohesion and creativity, which can enrich people's spiritual world, make socialist culture more colorful, and people's spiritual outlook[15]. Antiques are the crystallization of Chinese national culture. Behind each antique are the great achievements of the Chinese nation in the cultural field of various historical periods. Chinese culture has a long history and a long history, and it has a history of nearly 8,000 years[16]. Cultural scholars from all over the world have developed a keen interest in Chinese antique art. Figure 5 is a common antique collection:

Figure 5. Common antique collectibles

In the current society, we call the material cultural heritage created by ancient ancestors antiques or antiques. According to documentary records, the name of antiques began in the Qing Dynasty, so before the Qing Dynasty, everyone called it "Gudong", "Bone" means taking the flesh and keeping the bones, and "Dong" means understanding the essence left by the ancients[17-18]. From the perspective of cultural relics exhibition halls at all levels established by the country, antiques can be called cultural relics. From the perspective of appreciation and trading, everyone is used to calling it an antique. "Antique" means ancient wenwan, and refers to objects with aesthetic value created by predecessors. Narrowly speaking, it is an artwork with cultural relic value, historical value or scientific research value [19]. According to the literature, antiques appeared in all dynasties, until there were shops selling antiques in the Song Dynasty, and a professional antique market appeared in the Qing Dynasty.

Antiques are a concentrated reflection of the politics, economics, culture and customs of a dynasty, and they cannot be reproduced [20]. Later generations reproduced the habits and preferences of the ancestors and experienced the culture and beliefs of the ancestors through researching the artifacts left by the ancestors. Through archaeological discoveries, the collection culture can be traced back to the Shang Dynasty as early as the Shang Dynasty, and jade artifacts appear in the collection. It shows that collecting ancient jade is a contemporary cultural life [21].

In the history of Chinese plastic art, the Song and Yuan Dynasties were an important turning point. After that, the traditional plastic art became more and more secular, and the needs of the public were also considered in terms of modeling. However, after the Revolution of 1911, Chinese plastic art was accompanied by the impact of Western culture. The radical guiding ideology of total Westernization led to problems in the integration of Chinese plastic art and Western plastic art, and plagiarism, repetition and repetition continued to occur in artistic creation imitate. The reason for this phenomenon is that we do not understand Western history. Only when Chinese artists take the initiative to understand and study Western modern art, and combine them with traditional Chinese art, can they inherit and develop Chinese plastic art after a process of learning, reference, and research. Paying attention to China’s own national traditional culture has profound practical significance. It not only requires learning and borrowing from foreign cultures, but also deeply rooting in the native culture. This warns us that when developing modern ceramic art in Inner Mongolia, it must be combined with grassland culture. Only by rooting in such creative thinking can we create excellent ceramics that are truly in line with the current social trend, with a sense of artistic times and regional and ethnic characteristics art work.

In the process of learning and creating national ceramic art, success depends on whether we go deep into our hearts to find the inner meaning of the culture we think. This deepest inner meaning is the purpose of our artistic creation. The creation of ceramic works is not simply the use of traditional materials, techniques and language, but the inheritance of traditional ceramic skills with thinking, sublimation, and sublation. We must re-examine traditional materials and craftsmanship from the perspective of modern creation, and then select transformable national cultural resources for modern ceramic art creation. The public has different aesthetic orientations in different eras and different historical periods, and each era will develop and innovate. Folk culture, which is currently in the general trend of aesthetics, happens to meet the inner needs of modern people to return to peace and find the most primitive authenticity. This idea will gradually cause modern people's aesthetic changes. Folk culture, as the carrier of grassland national thoughts, its diversified expressions will have a profound impact on the creation of modern ceramic art.

3. Role of Ferroelectric Ceramic Materials Prepared Based on Nanoparticles in the Production of Antique Art

3.1. Nano Material Structure

As a new type of structural material, nanomaterials can convert wind energy into chemical energy as a ceramic capacitor, successfully achieving green and pollution-free, and it is closely related to the contemporary environmental protection concept [22].

Table 1. Nanomaterial structure

Point group(mm)	Crystal system	Temperature(℃)	Nature
5mm	Six parties	1460-1600	Non-ferroelectric
4mm	Quartet	110-10	Obvious ferroelectricity
3mm	Orthogonal	5-80	Spontaneous polarization
2mm	Tripartite	3mm	Orthogonal

According to the data in Table 1, when the temperature is lower than 1610℃, the material will change according to the change of temperature, and the crystal symmetry of the material will also change accordingly. Therefore, in this temperature range, the material exhibits three-sided, orthogonal, tetragonal and hexagonal structures [23]. When the environment is above the Curie temperature of 110 ℃, the material exhibits paraelectric characteristics, and when it is less than this temperature, it exhibits ferroelectric characteristics.

3.2. Ceramic Properties

In order to find the appropriate formula ratio, the flexural strength and toughness tests were done during the experiment. The specific conditions are as follows. According to the results, we can make finished products of different quality according to the requirements [24].

Table 2. Formulation flexural strength and toughness

	Type 1	Type 2	Type 3	Type 4
Zirconium dioxide/g	5	15	25	35
Alumina/g	85	75	65	55
Magnesium oxide/g	1	1	1	1
Bending strength	315	376	321	317
Toughness	3.32	5.61	3.49	3.19

According to the data in Table 2, in the first group of formulas, the content of zirconium dioxide is the least, and the content of alumina is the most. A small amount of zirconium dioxide and a large amount of alumina combine to form a consistent structure, and its bending resistance is slightly lower; In the second group of formulas, the proportion of zirconium dioxide is slightly higher than that of the first group, forming an internal crystal structure, and microcracks appear in the mutual contact with each material, and the crystals are finer. At this time, the bending resistance of the material is remarkable. Increase; in the third and fourth groups of formulas, the content of alumina is higher than that of magnesia, and the finished product has a glass binder phase at the grain boundary, with more pores, low density, and low bending resistance [25].

Table 3. Porosity and bulk density

	Type 1	Type 2	Type 3	Type 4
Zirconium dioxide/g	5	15	25	35
Alumina/g	85	75	65	55
Magnesium oxide/g	1	1	1	1
Porosity (%)	0.04	0.05	0.12	0.17
Bulk density (g/cm3)	3.93	4.25	3.32	4.53

According to the data in Table 3, the open pores of the four groups of formulas are small, which can be regarded as zero. This shows that the magnesium oxide and zirconium dioxide added in the experiment burned well. According to the data, the volume density also increased. Trend, this is closely related to the content of alumina and zirconia added in the formulation [26].

3.3. Hardness of Ceramic Materials

In order to test the hardness of ceramic materials, we designed four experiments during the experiment. By changing the content of different materials, the hardness of the finished product was changed to obtain the best ratio.

According to the data in Table 4, when the content of zirconia increases, the hardness of ceramics shows a decreasing trend. The reason is that the hardness of alumina is higher than that of zirconia. When the content of zirconia increases, the plastic deformation of the material will be more obvious, this will result in a decrease in the hardness of the material [27].

According to the above data, compared with bulk materials, powder has a larger specific surface area. When the particle diameter is smaller, it means that the contact is more uniform, the activity of nanomaterials will be more active, and the prepared ceramics have better density. Due to the different expansion coefficients of different grain boundaries, it will cause stress concentration. The use of small-particle powder materials can disperse the stress concentration, which can better solve this problem and reduce the cracking of ceramics [28].

Table 4. Ceramic hardness of each formulation

	Type 1	Type 2	Type 3	Type 4
Zirconium dioxide/g	5	15	25	35
Alumina/g	85	75	65	55
Magnesium oxide/g	1	1	1	1
Hardness (kgf/mm)	1715	1703	1681	1670

4. Role of Ferroelectric Ceramic Materials Based on Nano-Particles in the Production of Antique Art

4.1. Doping Comparison of Nanomaterials

In the experiment, controlling other variables unchanged, only changing the dopant will have a significant impact on the performance of the ceramic material. In order to compare the effects of different doping methods on the material, we will explore its control variables:

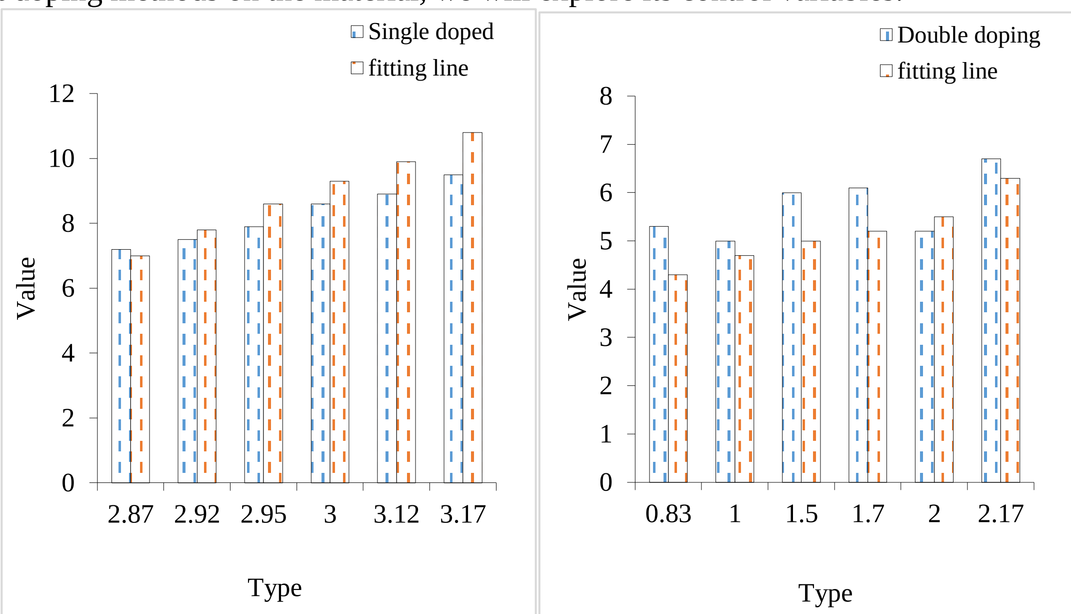

Figure 6. The effect of different doping on the finished product

According to Figure 6, the acceptor density is 1.03×1014 cm-2 in single doping, and 1.14×1014 cm-2 in double doping. These data indicate that the density of the substance in single doping is greater than that in double doping. By comparing the performance of different ceramic samples, it is found that the room temperature resistivity of the double-doped sample is much lower than that of the single-doped sample, and the average grain size of the two is not much different. The average grain size of the sample with single doping is 3.5 μm, and the average grain size of the sample with double doping is 4 μm. There is no obvious difference between the two on the whole [29].

4.2. Influence of Nanomaterial Doping on Ceramic Microcrystallization

When preparing nano-ceramic materials, the introduction of appropriate impurities can make them gather at the grain boundary to form an acceptor surface state. The ideal grain boundary structure can be formed by controlling the firing process, which is beneficial to improve the utilization rate of the material. However, during doping, it is found that the material distribution will be uneven after adding impurities. In order to improve this situation, the commonly used method is to dilute the incoming solution, and get different results according to the different conditions of the added solution.

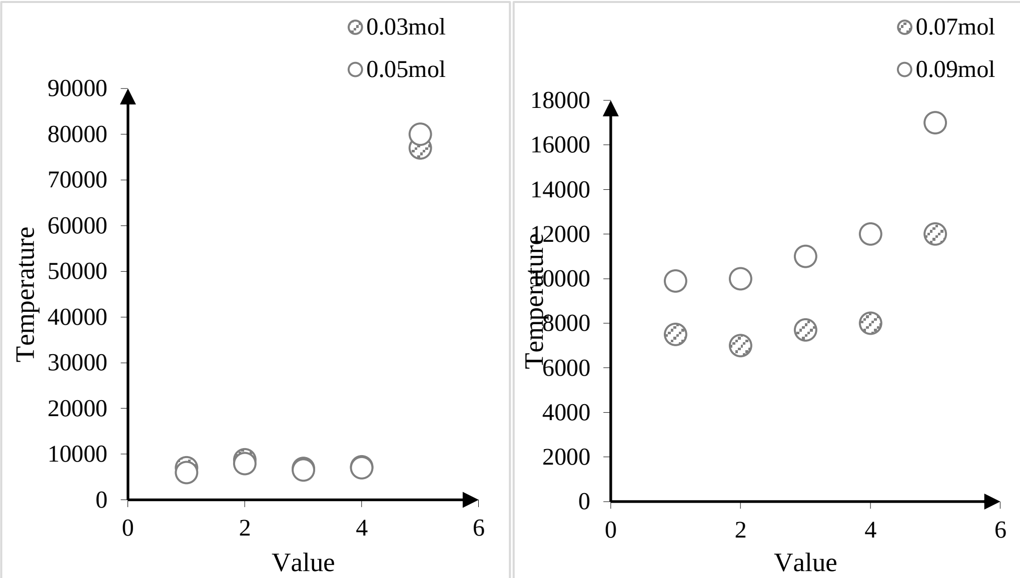

Figure 7. Schematic diagram of sample resistance temperature

According to the data in Figure 7, it can be observed that during the process of doping increasing from 0.03 mol to 0.09 mol, as the doping content increases, the room temperature resistivity of the sample shows a trend of change first and then rising. This is due to the effect of the doping, which reduces the effective doping content, which leads to weaker vacancy compensation and higher electron concentration, so the room temperature resistivity of the material begins to decrease. When the doping content is 0.09 mol, the acceptor will be enriched at the grain boundary or produce other phases, which is beneficial to increase the grain boundary barrier of the material, so the room temperature resistivity of the material begins to increase again.

4.3. Ceramic Burn-In and Sample Analysis

The hardness and strength of ceramics during the preparation process are relatively high, and it is too difficult to process them after sintering. In order to obtain a sample of a certain specification, it is best to perform a pre-sintering before sintering, then process it, and finally sinter to prepare the processed green body into the product required for the test.

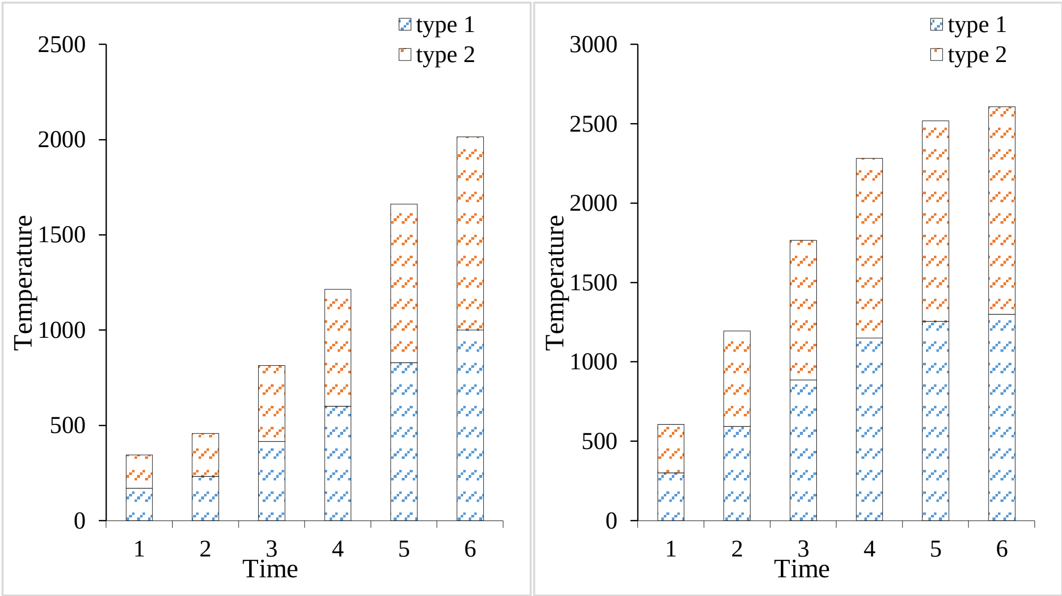

Figure 8. Ceramic heating rate

According to the data in Figure 8, when the operating temperature is about 100, the temperature rise rate is relatively slow, about 1.5 degrees per minute. This process is beneficial to increase the moisture in the equipment and can reduce the cracking caused by drying. When the temperature is about 500, the temperature rises about 3 degrees per minute, which helps the oxidation and decomposition of the forming agent. When the temperature is around 900 degrees, the temperature rises about 5 degrees per minute. This process heats up faster, which can avoid the excessive increase of crystal grains and save energy. When the temperature reaches 1100 degrees, it needs to be kept warm for 2 hours, turn off the power, and cool the embryo body naturally.

5. Conclusion

In this paper, through the research of nanocomposite ceramic materials, various properties of the materials prepared after treatment are analyzed. Experiments and explorations are mainly carried out from the aspects of doping modification and ferroelectric materials to discuss the influence of materials on the finished product. Through performance testing and characterization of a series of samples, it is concluded that the Curie temperature of the best-performing BaTiO3 ferroelectric ceramic material increases, the grain size decreases. The ferroelectricity gradually increases, and the density increases. At the same time, we hope to find a new way to make ceramics from the properties of nanomaterials. In this article, the following work has been mainly completed: (1) Using fiber to show the coating process and applying it to the surface treatment of ceramics, experiments have found that this method is feasible and improves the hardness of the ceramics. (2) The powders prepared under the two systems are sintered. When the sintering temperature is 1700 degrees, the preparation of almost completely dense nano-ceramics has been achieved. The process can reduce the sintering temperature to a certain extent. (3) As the doping content increases, the evaluation grain size of nanomaterials will decrease, and as the main material content increases, the average grain size of the material will gradually increase. (4) In the firing process, compared with the conventional firing method, the two-part firing method can refine the crystal grains and save energy. The higher the sintering temperature, the more it will promote the growth of crystal grains and promote the growth of crystal grains. Although certain rules were discovered during the experiment, there are still many limitations: (1) Nanomaterials are scarce and cannot be widely used in ceramic products, so it is clear to find more common materials. (2) With the development of science and technology, the material requirements for various finished products are becoming more and more stringent. Theoretically, the materials that need to be used in the experiment are powdered. However, due to my limited ability, I failed to reduce the average grain size of ceramics to Nano level.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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