

High corrosion resistance even at high temperatures biology essay

[Science](#), [Biology](#)



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CHAPTER 1

To prepare Kaolinite-Lead Oxide (PbO) via conventional solid state methodTo measure the dielectric properties, dielectric constant, ϵ' and dielectric loss, ϵ'' of Kaolinite-Lead Oxide. To investigate the effect of concentration variance in kaolinite matrix. To investigate the crystal structure, chemical composition, and physical properties of Kaolinite-Lead Oxide produced via X-ray scattering technique.

1. 2 Ceramic

1. 2. 1Introduction of ceramicCeramics are classified as inorganic and non-metallic materials that are fundamental to our daily lifestyle. Ceramic engineers are those who responsible to design the processes in which these products can be created and produced new types of useful products. Different uses for ceramic products in daily life are still waiting to be excavated. Ceramics are one of the most ancient man-made materials. The word ceramic is an extensive of Greek word " keramos" for " burnt stuff". Ceramics are made by reacting a combination of inorganic elements and

compounds at high temperatures around 2000°F. Ceramics are oxides or non-oxides composed of metallic and non-metallic elements. Most ceramics consists of one or more varieties of a metal oxide. Metal oxide is a compound of metal and oxygen. When metal is bonded to oxygen its properties can changes dramatically. Ceramic materials may have a crystalline, partly crystalline or amorphous structure. However, most of the ceramics are crystalline structure and that makes the definition of ceramic is often restricted to inorganic crystalline materials, as opposed to the non-crystalline glasses. Ceramics are generally made by shaping the mixtures of clay, earthen elements, powders, and water into desired forms. Once the ceramic has been shaped, it is heated in a very high temperature oven known as a kiln. Those atoms in ceramic materials are held together by a chemical bond. The two common chemical bonds for ceramic materials are ionic and covalent. In general, most ceramics resist corrosion, and being hard, durable, electrically insulating or semiconducting with various magnetic or dielectric properties. Traditional ceramics, such as tile, bricks, porcelain are necessary for commonplace activities, and newer varieties of ceramics have enabled dramatic improvements in computer technologies and communications. There are three basic categories of ceramics: Oxide Ceramics- Oxidation resistant, chemically inert, electrical insulating and generally low thermal conductivity. For example: alumina and zirconia. Non-oxide Ceramics- Low oxidation resistant and electrical conducting. For example carbides, borides, nitrides, silicides. Composites- Particulate reinforced, combination of oxides and non-oxides. Composites are tough, have low and high oxidation resistance, variable thermal and electrical conductivity. 1. 2. 2Ceramic

Matrix Composites Ceramic matrix composites (CMCs) are a subgroup of technical ceramics as well as a subgroup of composite materials. They consist of ceramic fibers that are embedded in a ceramic matrix, and thus a ceramic fiber is formed and then reinforced ceramic (CFRC) material. The fibers and matrix can consist of any ceramic material, whereby carbon and carbon fibers can also be considered as a ceramic material. The motivation to develop ceramic matrix composites was to overcome the problems associated by using the conventional technical ceramics like silicon carbide, alumina, silicon nitride, aluminium nitride or zirconia. They are easily fractured under mechanical or thermo-mechanical loads due to cracks that are initiated by small defects or scratches. Carbon (C), special silicon carbide (SiC), alumina (Al₂O₃) and mullite (Al₂O₃-SiO₂) fibers are most commonly used for CMCs. The matrix materials are usually the same, that is C, SiC, mullite and alumina. Short-fiber composites which are also called discontinuous fiber composites are produced by conventional ceramic processes from a non-oxide (silicon carbide) or an oxide (alumina) ceramic matrix reinforced by whiskers of titanium boride (TiB₂), silicon carbide (SiC), zirconium oxide (ZrO₂), aluminum nitride (AlN), and other ceramic fibers. CMC are mostly reinforced by silicon carbide fibers due to their stiffness and high strength. Short-fiber CMCs that have whiskers incorporated in it improve its toughness and resisting to cracks propagation. However, catastrophic is one of the character of failure short-fiber reinforced materials. On the other hand, long-fiber which are also called continuous composites are reinforced either by long monofilament of long multifilament fibers. The best strengthening effect is usually provided by a dispersed phase

in form of continuous monofilament fibers, which are fabricated by chemical vapour deposition (CVD) of silicon carbide on a substrate made of tungsten (W) or carbon (C) fibers. Monofilament fibers produce stronger interfacial bonding with the matrix material improving its toughness. Typical properties of long-fiber Ceramic Matrix Composites: High mechanical strength even at high temperatures; High stiffness; High thermal stability; Low density; High thermal shock resistance; High toughness; High corrosion resistance even at high temperatures. Ceramic composites may be produced by fundamental ceramic fabrication methods including mixing the powdered matrix material with the reinforcing phase followed by processing at elevated temperature: hot pressing, sintering. Such fabrication routes are successfully employed for preparing composites reinforced with a discontinuous phase (particulate or short fibers). However the composites reinforced with continuous or long fibers are rarely fabricated by conventional sintering methods due to mechanical damage of the fibers and their degradation caused by chemical reactions between the fiber and matrix materials at high sintering temperature. Additionally sintering techniques result in high porosity of the fiber reinforced composites.

1. 3 Kaolinite

1. 3. 1Introduction of KaoliniteKaolinite is a mineral belonging to the group of aluminosilicates. It is commonly referred to as " China Clay" because it was first discovered in Kao-Lin, China. The term kaolin is used to describe a group of relatively common clay minerals dominated by kaolinite and derived primarily from the alteration of alkali feldspar and micas. Kaolinite is an

industrial mineral used primarily as inert filler and customers combine it with other raw materials in a wide variety of applications. Kaolinite is white, soft, plastic clay mainly composed of fine-grained plate-like particles. It is formed when the anhydrous aluminium silicates which are found in feldspar rich rock, like granite, are altered by weathering or hydrothermal processes. The general composition of kaolinite is $\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4$, composed of sequences of tetrahedral sheet of silica layer and octahedral sheet of gibbsite layer, thus called a 1: 1 clay minerals like feldspar. It consists approximately 46% SiO_2 , 40% Al_2O_3 and 14% H_2O . Figure 1. 1: Structure of Kaolinite

Kaolinite is a clay mineral with the chemical composition $\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4$. The basic building blocks are layers of silica tetrahedral (with four apical O) and layers of alumina octahedral (with two apical O shared with silica and four apical OH), in a 1: 1 relationship. The sheets are created from planes, which are occupied as follows: $\text{O}_6 - \text{Si}_4 - \text{O}_4 - (\text{OH})_2 - \text{Al}_4 - (\text{OH})_6$

The kaolinite crystal is plate-like. The unit cell (5.14 Å by 8.93 Å by 7.37 Å) repeats in the x and y directions to form extensive sheets in the xy plane and stacks of sheets in the z direction formed by hydrogen bonds (HO—H) between OH of the alumina of one sheet and O of the silica of the next.

1. 3. 2 Structure Transformation of Kaolinite

Kaolinite type clays undergo a series of phase transformations upon thermal treatment in air at atmospheric pressure. Endothermic dehydroxylation (or alternatively, dehydration) begins at 550-600°C to produce disordered metakaolin, $\text{Al}_2\text{Si}_2\text{O}_7$, but continuous hydroxyl loss (-OH) is observed up to 900°C and has been attributed to gradual oxidation of the metakaolin. Due to historic disagreement concerning the nature of the metakaolin phase, extensive

research has led to general consensus that metakaolin is not a simple mixture of amorphous silica (SiO_2) and alumina (Al_2O_3), but rather a complex amorphous structure that retains some longer-range order (but not strictly crystalline) due to stacking of its hexagonal layers. 2

$\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4 \rightarrow 2 \text{Al}_2\text{Si}_2\text{O}_7 + 4 \text{H}_2\text{O}$. Further heating to 925–950 °C

converts metakaolin to an aluminium-silicon spinel, $\text{Si}_3\text{Al}_4\text{O}_{12}$, which is sometimes also referred to as a gamma-alumina type structure: 2

$\text{Al}_2\text{Si}_2\text{O}_7 \rightarrow \text{Si}_3\text{Al}_4\text{O}_{12} + \text{SiO}_2$. Upon calcination to ~1050 °C, the spinel phase ($\text{Si}_3\text{Al}_4\text{O}_{12}$) nucleates and transforms to mullite, $3 \text{Al}_2\text{O}_3 \cdot 2 \text{SiO}_2$, and highly crystalline cristobalite, SiO_2 : $3 \text{Si}_3\text{Al}_4\text{O}_{12} \rightarrow 2 \text{Si}_2\text{Al}_6\text{O}_{13} + 5 \text{SiO}_2$. 3.

3 Application of KaoliniteKaolinite possesses properties of fine particle size, platy shape, inertness, non-toxicity, and high brightness and whiteness which make it the most versatile mineral. Kaolinite is used in ceramics, medicine, coated paper, as a food additive, in toothpaste, as a light diffusing material in white incandescent light bulbs, and in cosmetics. It is also used in most paints and inks. The largest use in the production of paper, include ensuring the gloss on some grades of paper. Kaolinite is used both as a filler in the bulk of the paper and to coat its surface. Kaolinite's whiteness, opacity, large surface area and low abrasivity make it an ideal raw material for paper production. It allows a reduction in the amount of expensive wood pulp required, enhances the optical properties of the paper and improves its printing characteristics.

1. 4Lead(II) Oxide

Lead(II) oxide which also is called lead monoxide, is the inorganic compound with the molecular formula PbO. PbO occurs in two polymorphs, one having a tetragonal crystal structure and the other having an orthorhombic crystal structure. Modern applications for PbO are firstly in lead-based industrial glass and industrial ceramics, including computer components. <http://wikis.lib.ncsu.edu/images/2/22/PbO.png> Figure 1. 2: Structure of PbO When PbO occurs in tetragonal lattice structure it is called litharge and when the PbO has orthorhombic lattice structure it is called massicot. The PbO can be changed from massicot to litharge or vice versa by controlled heating and cooling. The tetragonal form is usually red or orange color, while the orthorhombic is usually yellow or orange, but the color is not a very reliable indicator of the structure. The two formats of PbO, tetragonal and orthorhombic, both occur naturally as rare minerals. The red and yellow forms of this material are related by a small change in enthalpy: $\text{PbO}(\text{red}) \rightarrow \text{PbO}(\text{yellow}) \Delta H = 1.6 \text{ kJ/mol}$ PbO is amphoteric, which means that it reacts with both acids and with bases. With acids, it forms salts of Pb^{2+} via the intermediacy of oxoclusters such as $[\text{Pb}_6\text{O}(\text{OH})_6]^{4+}$. With strong base, PbO dissolves to form plumbite(II) salts: $\text{PbO} + \text{H}_2\text{O} + \text{OH}^- \rightarrow [\text{Pb}(\text{OH})_3]^-$ Lead oxide is a dangerous compound. It may be fatal if swallowed or inhaled. It causes irritation to skin, eyes, and respiratory tract. It affects gum tissue, central nervous system, kidneys, blood, and reproductive system. It can bioaccumulate in plants and in mammals. 1. 4. 1 Application of Lead(II) Oxide The kind of lead in lead glass is normally PbO. PbO is used extensively in making glass. Depending on the glass, the benefit of using

PbO in glass can be one or more of increasing the refractive index of glass, decreasing the viscosity of glass, increasing the electrical resistivity of glass and increasing the ability of glass to absorb X-rays. Besides, adding PbO to industrial products makes the materials more magnetically and electrically inert and is often used for this purpose. Historically, PbO was also used extensively in ceramic glazes for household ceramics, and it is still used, but not extensively any more. Other less dominating applications include the vulcanization of rubber and the production of certain pigments and paints. PbO is used in cathode ray tube glass to block X-ray emission, but mainly in the neck and funnel because it can cause discoloration. The consumption of lead and hence the processing of PbO is correlated with the number of automobiles because it remains the key component of automotive lead-acid batteries.