



STUDIES ON BIOLOGICAL PROPERTIES OF TiO₂ AND ZnO

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ABSTRACT

Background: Biomaterials are abundant in the nature for the purpose of identifying the biofunctionality and biocompatibility. Titanium dioxide (TiO₂) and Zinc oxide (ZnO) are the most abundant biomaterials.

Methods: The biological effects were measured by two probe method and intensity relation. The biological properties of substances like concentration, conductivity, The pH-values, absorption coefficient and temperature effects were investigated for TiO₂ and ZnO.

Results: The results shows that temperature increases the thermal conductivity of the TiO₂ and ZnO also increases. Biological effects occurred at a lower rate in the given materials of the lower thermal conductivity. The pH-values depends on temperature. Temperature increases the pH-values decreases linearly for TiO₂ and ZnO. It indicate that antacid potential will be caused by the biological system of the materials. This behaviour depends on concentration of the TiO₂ and ZnO. The concentration of the TiO₂ and ZnO increases the thermal conductivity decreases exponential. Absorption coefficient decreases with increasing the thickness of the biomaterials.

Conclusion: The biological effects were observed at a particular concentration and temperature which was shown a special role in the metabolism of the flora, individual and industrial applications. These biological properties can be generally classified into energy, drug delivery and environmental types. The figure of merit found that the biological effects were more significant for TiO₂ and ZnO in biomedical applications such as restorative, implants and surgical.

Keywords: Absorption coefficient, concentration, thermal conductivity, temperature, TiO₂ and ZnO

INTRODUCTION

Biomaterials can be explained in terms of biocompatibility, biofunctionality and availability. Interaction of radiation

with the biomaterials have become major area of interest in the field of biomedical science. Thermoelectric are conceivably

the simplest technology for direct thermal to electric energy conversion. Titanium dioxide (TiO_2) is the most abundant biomaterial and exists in three primary phases. The attractiveness of titanium dioxide in materials sciences began with photo catalytic properties of different types of biomaterials [1]. Titanium dioxide is a white color found in all kinds of electronic components along with food and cosmetics. This material produced many hopeful uses in photo-electrochromics, inside layer and sensors. The new biological, physical and chemical properties come out when the size of the material becomes smaller down to the nanometer scale [2].

With the details of the biological response to an implant placement have been elucidate at the sub-cellular level. Zinc oxide (ZnO) is available an inorganic compound. The development of nanotechnology to improve its desired biological properties. Zinc oxide is playing a special role in the metabolism of individual. ZnO nanoparticle is the third highest nanoparticle produced and utilized in the different fields [3]. ZnO has again entered the scientific spotlight for its semiconducting properties [4]. Other favourable aspects of ZnO include radiation hardneess and high Curie temperature applications [5]. ZnO is a white powder that is insoluble in water. A huge number of polymer and composite have been used

on the basis of their ability to increase in biomedical applications [6]. The study of polymers coefficient has been an important in the fields of science and technology [7]. The conductivity depends on the concentration of ions and temperature. The chemical composition of the sample water determined its conductivity [8]. The change of intensity of the material can be explained in terms of absorption coefficient. Absorption coefficient depends on the material and also intensity which is being absorbed in biological environment [9].

The main intention in the selection of TiO_2 and ZnO is that they are playing a special attraction in biomaterials field. The biological properties of substances such as concentration, conductivity, The pH-values, absorption coefficient and temperature effects were investigated for TiO_2 and ZnO. The biological effects were measured by two probe method and intensity relation.

METHODOLOGY

Collection of sample

Zinc oxide (ZnO) nanomaterial was collected from company: MOLYCHEM, BATCH NO.MCR-16998. Zinc oxide (ZnO) exist an inorganic compound. Titanium dioxide was collected from company: MOLYCHEM, BATCH NO.MCR-13643. Titanium dioxide is stable, non-volatile and insoluble

biomaterial. All the chemicals used in this experiments were analytical grade. They are used without any further purification. Biomaterials was made in the form of pellet for absorption coefficient.

Experimental Details

The biological effects were measured by two probe method using KITHELY-2700 model. A voltage was applied between the two electrodes in the probe of the sample water. The drop in voltage caused by the resistance of the water. The conductivity (σ) is the inverse of resistivity (R) and is determined from the voltage (V) and current (I) relation by Ohm's law. The thermal conductivity was measured by two probe method and can be represented as Siemens per centimetre(S/cm).

$$\sigma = \frac{1}{R} = \frac{I}{V} \quad (1)$$

The estimated absorption coefficient was measured based on the intensity relation

$$I(x) = I_0 e^{-\mu} \quad (2)$$

Measurement of the pH-values

The pH stand for potential of hydrogen. The pH-meter is a scientific instrument that measures the hydrogen-ion activity in water based solution indicates its acidity or basic expressed as pH. The pH is effectively a measure of the concentration of hydrogen ions in a given substance. The range goes to 0 to 14, with 7 being neutral.

The pH values less than 7 indicate acidity, where a the pH values greater than 7 indicates a base [10].

RESULTS

The biological properties of substances such as concentration, conductivity, The pH-values, absorption coefficient and temperature effects were investigated based on two probe method for TiO₂ and ZnO biomaterials and intensity relation. The results shows that the biological effects were more significant for TiO₂ and ZnO in biomedical applications such as restorative dental materials, implants and surgical. Key factors in a biomaterials treatment were its biocompatibility, biofunctionality and availability to a lesser extent. The figure of merit found that temperature increases the thermal conductivity of the TiO₂ and ZnO also increases. Biological effects occurred at a lower rate in the given materials of the lower thermal conductivity. Temperature increases the pH-values decreases linearly for TiO₂ and ZnO. The concentration of the TiO₂ and ZnO increases the thermal conductivity decreases exponential. The biological effects were observed at a particular concentration and temperature which was shown a special role in the metabolism of the plants, pharmaceutical and biomedical applications. Absorption coefficient

decreases with increasing the size of the biomaterials. These biological effects can be generally classified into energy, drug delivery, biomedical and environmental types.

The variation of temperature versus thermal conductivity were shown in **(Figure 1)**. Thermal conductivity effects were temperature dependent. The temperature increases the thermal conductivity of the TiO_2 and ZnO also increases. Heat transfer occurred at a lower rate in the given materials of the lower thermal conductivity. In particular one needs a combination of high conductivity and high thermopower and one needs high conductivity and low lattice conductivity. Temperature versus the pH-values were shown in **(Figure 2)**. Temperature increases the pH-values decreases linearly for TiO_2 and ZnO . It indicate that antacid potential will be caused by the biological system of the human being. The pH-values depends on temperature. The pH is defined as the decimal logarithm of the reciprocal of the hydrogen ion activity in a given solution. This behaviour depends on concentration of the TiO_2 and ZnO . The biological effects were observed at a particular concentration and which was shown a special role in the metabolism of the plants, human being and industrial applications.

The concentration of the TiO_2 and ZnO increases the thermal conductivity decreases exponential were shown in **(Figure 3)**. The TiO_2 and ZnO can be used as an stabilizer into various materials. These materials are also used every day in drug delivery and medical applications. Biological properties widely used in the biomaterials science include biology, chemistry, medicine, tissue engineering and material science. Conductivity shown fundamental property that quantifies how strongly a given material opposes the flow of electric current. Metal has a high conductivity and temperature factors have a large effect on conductivity. Thermal conductivity depends on the concentration of ions, the pH-values and temperature.

Absorption coefficient with variation of thickness were shown in **(Figure 4)**. The absorption coefficient depends on sample size, material density, intensity of incident light. Knowing the absorption coefficients of materials determining which material to use in solar cell designs, biological shield and photocatalytic applications. Different materials have different absorption coefficients. ZnO has been doped with different metals for improving transport energy efficiency. Due to doping ZnO nanoparticle displayed promising biomedical applications dependent on its

anticancer and antibacterial properties through photoinduced oxidation process. The bioavailability of the ZnO to helpful as medication transporters to accomplish upgraded treatment productivity. Biological properties also changes in the material host with inorganic and organic dyes. General mechanism of the photocatalysis were shown in **(Figure 5)**. Biological effects have been suggested that quality control of the drinking water can be engaged effectively.

The real research and development in the radiation science and biotechnology concern with making modifications in its atomic and molecular level. Figure of merit found for biological properties of TiO_2 and ZnO were shown in **(Table 1)**. The motion of electrons and holes in semiconductor nanomaterials primarily controlled by the common quantum confinement. The transport properties connected with phonons and photons are largely influenced by the size of the material. The most popular commercially available nano size materials that has originate different applications in a variety of fields due to its wide availability, biocompatibility, low cost, non-toxicity and high chemical stability. These uses can be generally classified into energy, drug delivery, biomedical, tissue engineering and environmental types.

TiO_2 and ZnO materials were also used every day in drug delivery and medical applications. Biomaterials were used widely in modern restorative dentistry. The coupling of TiO_2 to a narrow gap semiconductor material can result in an increase in photocatalytic reactivity and as well as an increase in conductivity response. The biological effects of substances such as concentration, conductivity, The pH-values, absorption coefficient and temperature were an important parameters in biology, pharmacy and allied sciences. These properties extensively used in the biomaterials science consist of biology, chemistry, medicine and material science. Applications of TiO_2 and ZnO were shown in **(Table 2)**. Recombination of the charge carriers results energy is released in the form of heat. This causes great reduction in photocatalysis efficiency. The photocatalysis performances were affected by several parameters such as concentration, light intensity, conductivity, pH-values and temperature. These biological properties play a significant role included air purification, water purification, decontamination, antibacterial, tooth paste, photocatalysis, sensing and paint applications.

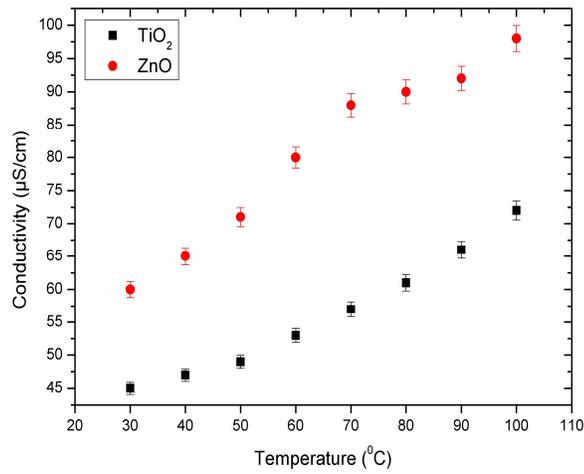


Figure 1: Temperature versus conductivity

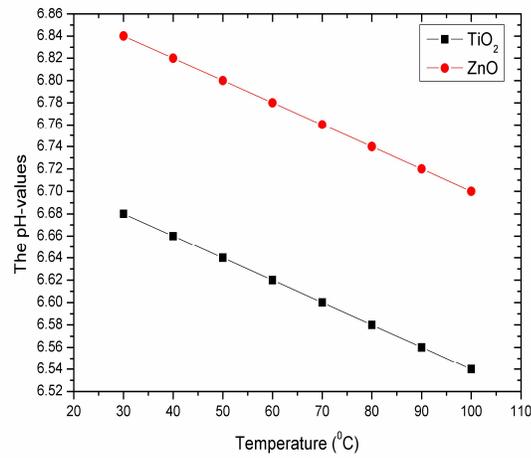


Figure 2: Temperature versus the pH-values

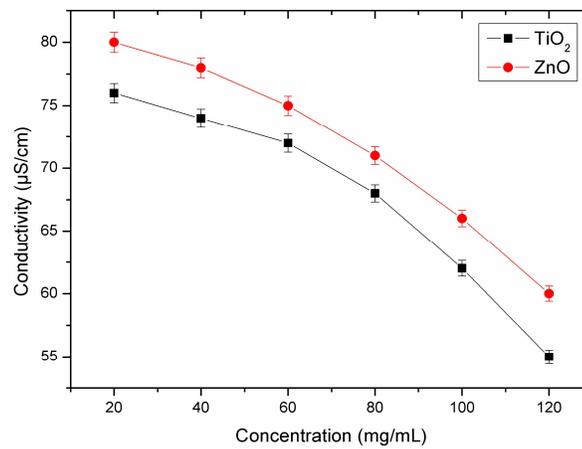


Figure 3: Concentration versus conductivity

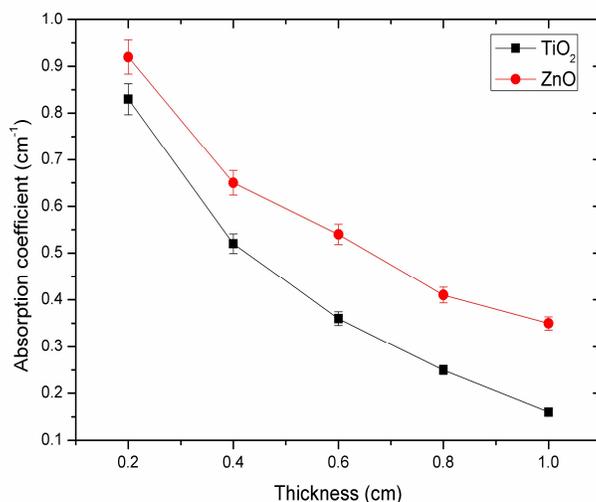


Figure 4: Absorption coefficient with variation of thickness

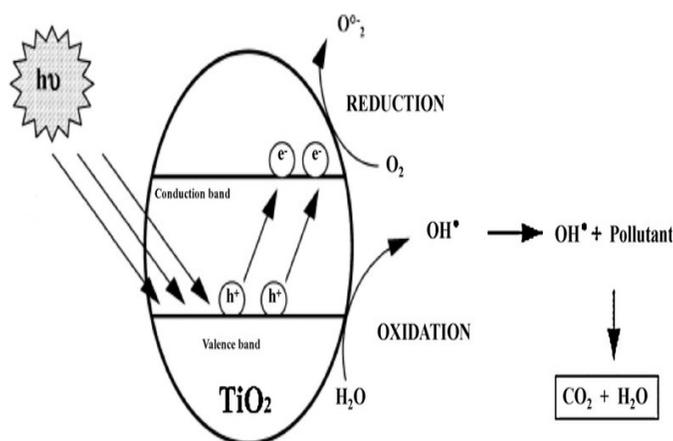


Figure 5: General mechanism of the photocatalysis

Table 1: Figure of merit found for biological Properties of TiO₂ and ZnO

Biological Properties	TiO ₂	ZnO
Thermal Conductivity	Metals have a high conductivity. Conductivity is a fundamental property that quantifies how strongly a given material opposes the flow of electric current.	Even though many purification techniques are available but conductivity is one of the water purification technique.
Concentration	Thermal conductivity depends on the concentration of ions and the pH-values. Transport properties have been suggested that quality control system.	The biological effects were observed at a particular concentration and play a special role in the metabolism of the plants, human being.
Temperature	Thermal conductivity are temperature dependent. Based on this concept the TiO ₂ and ZnO can be used as an stabilizer into various materials.	Temperature increases the pH-values decreases linearly. This behaviour depends on concentration of the TiO ₂ and ZnO.
The pH-values	The pH-values depends on temperature. The pH-values of the given material also used every day in drug delivery and medical applications.	The real research and development in the science and technology is concern with making modifications in its atomic and molecular level.
Absorption coefficient	Based on absorption coefficient behaviour may act as potent protectives against harmful exposure	In terms of shielding zinc oxide compounds were more suitable at low cost and yield significant results on various aspects.

Table 2: Biology, Pharmacy applications of TiO₂ and ZnO biomaterials

Applications	TiO ₂	ZnO
Photocatalysis	The attractiveness of titanium dioxide in materials sciences began with photo catalytic properties of different fields.	Zinc oxide is playing a special role in the metabolism of human beings, plants and communication system.
Biomedical	Titanium dioxide used for biomedical application such as restorative composite materials.	Zinc oxide used for biomedical application such as liners and bases of dental materials.
Nanosensors	TiO ₂ nanosensors for air quality monitoring.	Monitoring and detecting traces of contaminants in the environments.
Potentially low cost	Titanium dioxide is the most abundant element in earth crust.	Zinc oxide is available an inorganic compound.
Cosmetics	TiO ₂ used for toothpaste, soap.	ZnO used in water treatment agent
Industrial	TiO ₂ is the most usefull material for Paints, coatings, and textiles, etc.	ZnO is also used for industrial products like coated fabrics and ceramics.
Nanotechnology	TiO ₂ nanomaterials can be used for optical or electrochemical detection.	ZnO nanomaterial used for sensing and detection of biological contaminants in water.
Consumer Products	TiO ₂ has the high sensitivity and selectivity it can be used for water purification system.	ZnO has the high sensitivity and it can be used for water quality control.

DISCUSSION

Studies on biological effects on biomaterials play an very important in modern and biological applications. Biomaterials currently produced commercially and were used in modern restorative materials. Most of the biological effects can be observed in biomaterials with water substance. Water show the most important substances for all life on earth and development. Zinc as ion have significant role in bioavailability. The properties also differ in terms of the shapes and size in the shrinking nano-materials [11]. Several methods have been reported for synthesis of ZnO nanomaterials. It is simple method for the synthesis of nanopowders of metaloxides which are highly reactive in low temperature. A series of investigations on photocatalytic disinfection have been intensively conducted on a wide range of microorganisms such as viruses, fungi and

many species of bacteria [12-14]. Zinc oxide usually a semiconductor having wide band gap of 3.37 eV at normal room temperature. Zinc oxide is analyzed to be a technologically remarkable material. Based on unique characteristics of nanomaterials were being fabricated and applied for wide range of commercial and industrial applications. The outline dependence of the products on pH-values, and other additives showed an improvement in biomaterial science.

TiO₂ and ZnO materials were also used every day in drug delivery and biomedical applications. The coupling of TiO₂ to a narrow gap semiconductor material can result in an increase in photocatalytic reactivity and as well as an increase in conductivity response. The functionalization of biomaterials with polymers exhibits good biological properties. TiO₂ naturally occurring mineral as bright white pigment. TiO₂ has been prepared

thin layers with a high photocatalytic activity and antibacterial properties for use as a self-cleaning transparent coatings for windows in outdoors applications [15-16]. TiO₂ shows stable, non-volatile and largely insoluble. TiO₂ considered to be a very safe biomaterial and non-toxic [17]. The activated charge carriers react with atmospheric oxygen and water molecules to produce reactive oxygen species [18]. Titanium dioxide has been integrated into bioactive glass composites. High atomic number and high-density materials are the best effective characteristics of radiation shielding materials [19]. Size dependence nanomaterials play vital role in biomedical field due to biocompatibility and biological matrix of biomaterial [20]. For various modern fields of science and technology, including microbiology, nanobiotechnology and fundamental medicine. Thus the most popular directions include the design of new generation of drugs based synthetic materials [21].

CONCLUSION

The biological properties of substances such as concentration, conductivity, The pH-values, absorption coefficient and temperature were investigated by two probe method and intensity relations for TiO₂ and ZnO biomaterial. Temperature increases the thermal conductivity of the TiO₂ and ZnO

also increases. Heat transfer occurred at a lower rate it indicate that antacid potential will be caused by the biological system of the materials. Absorption coefficient behaviour may act as potent protectives against harmful exposure and on various aspects in terms biological shielding. The biological effects were observed at a particular concentration and temperature, which was shown a special role in the metabolism of the plants, human being, biomedical and industrial applications. These uses can be generally classified into energy, drug delivery, biomedical, pharmaceutical and environmental types. The figure of merit found that the TiO₂ and ZnO can be used as a stabilizer into various materials modifications and applications. For better understanding of the nature of transport properties of material it is proposed to carry compositional studies, optical and dielectric studies.

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