NANO ZINC OXIDE FOR UV PROTECTION CREAM

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ABSTRACT

Zinc oxide (ZnO) is chemical compound with very wide industrial and commercial applications, particularly as pigments. Due to physical properties, also used as UV protection ingredients for protect from UV radiation. At the nanoparticles, Zinc oxide have proven to have a similar level of protection compared to normal-scale sunscreen particles. An advantage of the topical use of nanoparticle ingredients in UV protection cream is their transparency compared to the white residue left on skin with normal scale particles. UV protection cream contain insoluble zinc oxide nanoparticles, which are colorless and reflect or scatter ultraviolet (UV) more efficiently than larger particles. Most available theoretical suggests that insoluble nanoparticles do not penetrate into or through normal as well as compromised human skin. Overall suggests that nano materials as zinc oxide nanoparticles currently used in UV protection cream preparations no risk to human skin or human health.

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Chapter 1

Introduction

1.1 Motivation

Nanotechnology is the creation of new material, devices, and systems through the control of matter on the nanometer-length scale, at the level of atoms and molecules. The essence of nanotechnology is the ability to work at these levels to generate nanostructures with fundamentally new molecular organization. Finely dispersed nanostructure or nanoparticles are used in numerous technological and medical applications such as ceramic, polymer composites, filter material, pigment, electronic, catalysts and many others. Several techniques have been developed for such particles, some based on physical and some based on chemical principles. Used mechanical grinding as a means to attain particles in the nanoscale (<100 nm) is not practical for various reasons:

- The grain distribution is large.
- Obtaining particles smaller than 1um is usually difficult, and can not be controlled easily.
- The shape is irregular due to non-directed cracking.
- Distribution is broad and uncontrolled.

Ultraviolet radiation (UV) responsible for the growing epidemic of skin cancer in the countries where are located in tropical zone including Thailand. Humans are increasingly exposed to it as the ozone is depleted and/or global warming intensifies reflection. Ultraviolet is a description of the band of sunrays that fall in the middle of the magnetic spectrum. The length of these rays is shorter than visible light but longer than x-rays, and include UVA, UVB and UVC.

In the past, studying about zinc oxide nanoparticles for developed UV protection cream. Historically, zinc oxide has been used on a limited basis in personal care applications because of it's thick, white pasty appearance. By reducing the zinc oxide to nano size, it becomes inherently transparent when applied to the skin but maintains it's ability to effectively block UVA and UVB radiation. Zinc oxide nanoparticles is highly effective in protecting against both UVA and UVB radiation, providing full spectrum UV Protection. UV rays are part of the non-visible portion of sunlight and are split into two categories based on their wavelengths. The longer wavelength UVA spans from 320 to 400 nanometers, and the shorter wavelength UVB spans from 280 to 320 nanometers. UVA is mainly responsible for skin tanning, but also penetrates deep into the skin causing damage associated with skin wrinkles as well as increasing the risk of skin cancer. The effects of UVB can cause skin inflammation in a short exposure time, which is commonly referred to as a sun burn. Zinc oxide nanoparticles showed excellent ability in resisting UVA and UVB. It also displayed grain subtlety, high purity, and extremely low harmful impurity material. It is also suitable for the use in makeup UV protection products to block the UV away from human body.

1.2 Objectives

This project intended to study about characterization of UV protection cream that prepare from zinc oxide nanoparticles, study performances and benefits of nano zinc oxide UV protection cream.

1.3 Scope of Study

1.3.1 Characterization of nano zinc oxide for UV protection cream.

1.3.2 Preparation UV protection cream by used zinc oxide nanoparticles as a UV absorber.

1.3.3 Study the performance of nano zinc oxide UV protection cream.

1.4 Expected results

1.4.1 Obtain nano zinc oxide UV protection creams have a good quality and can be used.

1.4.2 Nano zinc oxide UV protection creams have an inexpensive cost when compared with the commercial UV protection cream that available on the market today.

Chapter 2

Literature review

Part 1. Material

2.1 zinc oxide nanoparticles (ZnO nps)

Zinc oxide is an inorganic compound with the formula ZnO. It usually appears as a white powder, nearly insoluble in water. The powder is widely used as an additive into numerous materials and products including plastics, ceramics, glass, cement, rubber, lubricants, paints, ointments, adhesives, sealants, pigments, foods (source of Zn nutrient), batteries, ferrites, fire retardants, first aid tapes, etc. Zinc oxide is present in the Earth crust as a mineral zincite; however, most Zinc oxide used commercially is produced synthetically. In materials science, Zinc oxide is often called a II-VI semiconductor because zinc and oxygen belong to the 2nd and 6th groups of the periodic table, respectively. This semiconductor has several favorable properties: good transparency, high electron mobility, wide band gap, strong room-temperature luminescence, etc. Those properties are already used in emerging applications for transparent electrodes in liquid crystal displays and in energy-saving or heat-protecting windows, and electronic applications of zinc oxide as thin-film transistor and light-emitting diode are forthcoming as of 2009.

Zinc oxide occurs as white powder known as zinc white or as the mineral zincite. The mineral usually contains a certain amount of manganese and other elements and is of yellow to red color. Crystalline zinc oxide is thermochromic, changing from white to yellow when heated and in air reverting to white on cooling. This color change is caused by a very small loss of oxygen at high temperatures to form the non-stoichiometric $Zn_{1+x}O$, where at 800 °C, x= 0.00007. Zinc oxide is an amphoteric oxide. It is nearly insoluble in water and alcohol, but it is soluble in (degraded by) most acids, such as hydrochloric acid:

$$ZnO + 2\,HCl \longrightarrow ZnCl_2 + H_2O$$

Bases also degrade the solid to give soluble zincates:

$$ZnO + 2\,NaOH + H_2O \longrightarrow Na_2(Zn(OH)_4)$$

Zinc oxide reacts slowly with fatty acids in oils to produce the corresponding carboxylates, such as oleate or stearate. Zinc oxide forms cement-like products when mixed with a strong aqueous solution of zinc chloride and these are best described as zinc hydroxy chlorides. This cement was used in dentistry. Zinc oxide also forms cement-like products when treated with phosphoric acid; related materials are used in dentistry. A major component of zinc phosphate cement produced by this reaction is hopeite, $Zn_3(PO_4)_2 \cdot 4H_2O$. Zinc oxide decomposes into zinc vapor and oxygen only at around 1975 °C, reflecting its considerable stability. Heating with carbon converts the oxide into the metal, which is more volatile than the oxide.

$$ZnO + C \longrightarrow Zn + CO$$

Zinc oxide can react violently with aluminum and magnesium powders, with chlorinated rubber and linseed oil on heating causing fire and explosion hazard. It reacts with hydrogen sulfide to give the sulfide: this reaction is used commercially in removing H_2S using zinc oxide powder (e.g., as deodorant).

$$ZnO + H_2S \longrightarrow ZnS + H_2O$$

When ointments containing zinc oxide and water are melted and exposed to ultraviolet light, hydrogen peroxide is produced.Most applications exploit the reactivity of the oxide as a precursor to other zinc compounds. For material science applications, zinc oxide has high refractive index, good thermal, binding, antibacterial and UV-protection properties. Consequently, it is added into various materials and products, including plastics, ceramics, glass, cement, rubber, lubricants, paints, ointments, adhesive, sealants, pigments, foods, batteries, ferrites, fire retardants, etc. Microfine zinc oxide (Z-cote) is becoming more popular because it is shown to protect over a wide range of UVA including UVA1 (up to 380 nm). It is photostable and does not react with other organic UV protection cream. It is more effective in UVA protection than microfine titanium dioxide, which protects against UVB and UVA2, and is less protective against UVA1. Titanium dioxide has higher refractive index than zinc oxide, which makes titanium dioxide whiter (even though the particle size is smaller) and more difficult to incorporate into products that are minimally visible to the eyes. Moreover, titanium dioxide is more photoreactive than zinc oxide. Photoexcited micronized titanium dioxide has been shown to cause cell death in vitro, although no evidence exist on its in vivo toxicity.

Zinc oxide nanoparticles can be synthesized into a variety of morphologies including nanowires, nanorods, tetrapods, nanobelts, nanoflowers, nanoparticles etc. Nanostructures can be obtained with most above-mentioned techniques, at certain conditions, and also with the vapor-liquid-solid method. Many zinc nanoparticles can be produced via aqueous methods. They are attractive because of relatively low synthesis temperatures (<300 °C) and absence of complex vacuum setup. Aligned zinc oxide nanowires on pre-seeded silicon, glass and gallium nitride substrates have been grown in aqueous solutions using aqueous zinc salts such as zinc nitrate and zinc acetate in basic environments.

Figure 2.1.1 SEM images of Zinc oxide nanoparticles.

Figure 2.1.2 TEM images of Zinc oxide nanoparticles.

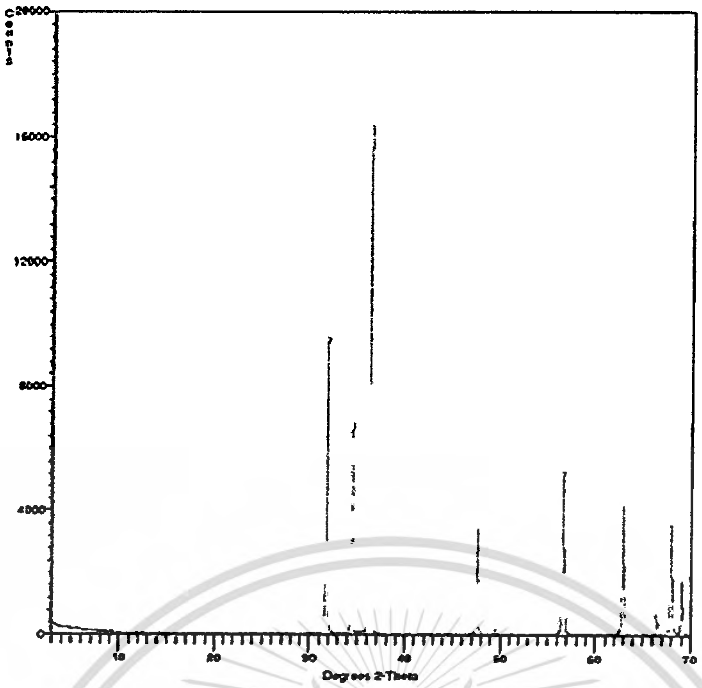


Figure 2.1.3 XRD scan of Zinc oxide nanoparticles.

Zinc oxide nanoparticles applications

The applications of zinc oxide powder are numerous, and the principal ones are summarized below. Most applications exploit the reactivity of the oxide as a precursor to other zinc compounds. For material science applications, zinc oxide has high refractive index, high thermal conductivity, binding, antibacterial and UV-protection properties. Consequently, it is added into various materials and products, including plastics, ceramics, glass, cement, rubber, lubricants, paints, ointments, adhesive, sealants, pigments, foods, batteries, ferrites, fire retardants, etc.

- Cosmetic Industry
- Pharmaceuticals
- UV protection cream and Sunblock Manufacturers
- Outdoor Wood treatment
- Cream Thickener

Some of the popular applications of zinc oxide are in the following industries :

- Rubber

The rubber industry, in its development over the past one hundred years, has utilized an increasing number of the many optical, physical and chemical properties of Zinc Oxide. Zinc Oxide proved the most effective activator to speed up the rate of cure with the new accelerators. Heavy-duty pneumatic tires carry high loadings of Zinc Oxide for heat conductivity as well as reinforcement since heat-buildup is critical at their higher operating speeds compared with their solid-rubber counterparts.

- Activation

In the curing process for natural rubber and most types of synthetic rubbers, the chemical reactivity of Zinc Oxide is utilized to activate the organic accelerator. The unreacted portion of the Zinc Oxide remains available as a basic reserve to neutralize the sulfur-bearing acidic decomposition products formed during vulcanization. Adequate levels of Zinc Oxide contribute markedly to chemical reinforcement, scorch control, and resistance to heat-aging and compression fatigue.

- Acceleration

Zinc oxide serves as the accelerator with some types of elastomer and the crosslinking, which it induces, takes several forms. With some systems, zinc oxide is an effective co-accelerator in the vulcanization process.

- Biochemical Activity

Zinc Oxide is useful in the preservation of plantation latex as it reacts with the enzyme responsible for the decomposition. The oxide is also a fungistat, inhibiting the growth of such fungi as mold and mildew.

- Dielectric Strength

In high-voltage wire and cable insulation, Zinc Oxide improves the resistance to corona effects by its dielectric strength, and at elevated operating temperatures it contributes to maintenance of the physical properties of the rubber compound by neutralization of Acidic decomposition product.

- Heat Stabilization

Zinc oxide similarly retards devulcanization of many types of rubber compounds operating at elevated temperatures.

- Latex Gelation

In the production of latex foam rubber products, Zinc oxide is particularly effective in gelation of the foam with sufficient stability.

- Light Stabilization

Zinc oxide is outstanding among white pigments and extenders for its absorption of ultraviolet rays. Thus, it serves as an effective stabilizer of white and tinted rubber compounds under prolonged exposure to the destructive rays of the sun.

- Pigmentation

Through its high brightness, refractive index, and optimum particle size, zinc oxide provides a high degree of whiteness and tinting strength for such rubber products as tire sidewalls, sheeting and surgical gloves.

- Reinforcement

Zinc oxide provides reinforcement in natural rubber, and in some synthetic elastomers such as polysulfides and chloroprenes. The degree of reinforcement appears to depend upon a combination of the particle size of the oxide, the finest size being the most effective, and the reactivity of the oxide with the rubber. Under such service condition involving rapid flexing or compression, zinc oxide also provides heat conduction to more rapidly dissipate the heat and thereby provides lower operating temperatures. In addition, it imparts heat stabilization by reacting with acidic decomposition products.

- Rubber-Metal Bonding

In the bonding of rubber to brass, zinc oxide reacts with copper oxide on the brass surface to form a tightly adhering zinc-copper salt.

- Tack Retention

One of the unique properties of zinc oxide is its ability to retain over many months of shelf – storage the tack of uncured rubber compounds for adhesive tapes. French process Zinc Oxides impart heat-aging resistance superior to that of American-process zinc oxides. The former type, being sulfur-free, has a higher pH and, thus, can neutralize more effectively the acidic decomposition products formed during aging. Moreover, the finer French-process zinc oxides prove superior to coarser grades in heat-aging resistance.

- Plastics

Zinc compounds can provide a variety of properties in the plastics field. Heat resistance and mechanical strength are imparted to acrylic composites by zinc oxide. Zinc oxide contributes to the formation and cure of epoxide resin. Addition of zinc oxide to epoxy resins cured with aliphatic polyamines imparts higher tensile strength and water resistance. Zinc oxide imparts fire-resistant properties to nylon fibers and moldings. Zinc oxide is also useful in the preparation of nylon polymers and in increasing their resistance. The formation of polyesters in the presence of Zinc oxide imparts higher viscosity and other improvements. Zinc oxide reacts with unsaturated polyesters to form higher viscosity and a thixotropic body. The dyeability of polyester fibers is improved by zinc oxide. Zinc oxide mixtures stabilize polyethylene against aging and ultraviolet radiation. Zinc oxide increases the transparency of poly (chlorofluoroethylene) molding resin. Polyolefin's are improved in color, tensile strength, and vulcanization properties by addition of Zinc oxide. Thermal stabilization of PVC is effected by Zinc oxide. Antistatic, fungistatic and emulsion stability are additional properties imparted to vinyl polymers by Zinc oxide. Applications in development for Zinc oxide-stabilized polypropylene and high-density polyethylene include safety helmets, stadium seating, insulation, pallets, bags, fiber and filament, agricultural and recreational equipment.

- Ceramics

The properties imparted by zinc oxide to some of the newer applications are as electronic glass, low-melting glass for metal-to-glass seals, thermistors for use as lighting arresters and devitrified glasses of low thermal expansion. Zinc oxide imparts a unique combination of properties when used in glass. Zinc oxide reduces the coefficient of thermal expansion, imparts high brilliance and luster and high stability against deformation under stress. As a replacement flux for the more soluble constituents, it provides a viscosity curve of lower slope. The specific heat is decreased and the conductivity increased by the substitution of zinc oxide for BaO and PbO.

- Pharmaceutical Industry

Zinc oxide is mainly used in zinc soap, ointment, dental inlays, food powders etc. Zinc oxide forms an indispensable element of the production process of this industry.

- Cosmetics

The optical and biochemical properties of zinc oxide and its derivatives impart special features to a variety of cosmetic preparations for care of the hair and skin. In powders and creams it protects the skin by absorbing the ultraviolet sunburn rays; in burn ointments it aids healing. Simple salts of zinc provide astringent and skin-conditioning properties to creams, while more complex salts furnish fungistatic properties which contribute to the effectiveness of deodorants, soaps, and antidandruff preparations.

- Adhesives, Mastics, Sealants

Zinc oxide has long been a major constituent of surgical and industrial tapes based on natural or synthetic rubber as it is outstanding in retention of tack during shelf–aging. Neoprene adhesives are improved by the addition of both Phenolic resins and zinc compounds (including Zinc Oxide), the reaction products imparting special properties such as high heat resistance, high bond strength, improved peel and shear – stress resistance, and stability to settling of Neoprene solution adhesives.

- Photocopying

Some of the unique electronic properties of zinc oxide are distinctively utilized in the photocopying process. For use in that process, zinc oxide is increased in photoconductivity and semiconductor properties by special heat and/or doping treatments (addition of foreign elements). Also, zinc oxide is greatly modified in optical properties to increase its absorption of light rays in the visible region. This process known as sensitization, is generally carried out by addition to certain dyes, which are absorbed on the surface of the zinc oxide. Commercial zinc oxide for photocopying is generally produced from metallic zinc, rather than ore, to obtain a product of higher purity.

- Lubricants

In the research and development of improved lubricants over the past two decades, zinc oxide and its derivatives have been intently studied. Zinc Dithiophosphates which are prepared by reacting zinc oxide with organic Phosphates, are used in substantial quantities as additives to lubricating oils for automotive engines, to reduce oxidation corrosion and wear. Zinc oxide has been found to contribute special properties in many types of lubricants, such as extreme-pressure lubricants, seizure-resistant lubricants, and greases. Improved adhesion is another feature which zinc oxide contributes. Zinc oxide imparts special properties to greases and other variety of lubricants. Such greases are useful in the lubrication of food–processing equipment

- Paints

Zinc oxide in organic coatings provides a broad spectrum of properties: optical, chemical, biochemical and physical. Over the past century the paint industry, in its constant development of improved products, has utilized various aspects of those properties to high degree. Manufacturers discovered that they could produce coatings of brushing consistency and good suspension properties by incorporation of zinc oxide into their pastes. Painters noted that they furnished better hiding power, whiteness, cleaner tints, tint retention, and durability as well as non darkening in the presence of sulfur fumes. French-process zinc oxide has been proved superior to American-process type in fungus resistance and less sulfide staining.

- Metal – Protective Coatings

Zinc metal powder (zinc dust) and zinc compounds have long been utilized for their anticorrosive properties in metal-protective coatings, and today they are the basis of such important specially metal primers as Zinc Chromate primers. Zinc dust-zinc oxide paints are especially useful as primers for new or weathered galvanised Iron. Such surfaces are difficult to protect because their reactivity with organic coatings leads to brittleness and lack of adhesion. Zinc dust-Zinc oxide paints however, retain their flexibility and adherence on such surfaces for many years. Zinc dust-Zinc oxide paints also provide excellent protection to steel structures under normal atmospheric conditions, as well as to steel surfaces in such under-water conditions as dam faces and the interior of fresh water tanks.

- Cigarette Filters

Zinc oxide as a constituent of cigarette filters is effective in removal of selected ingredients from tobacco smoke. A filter consisting of charcoal impregnated with zinc oxide and Iron oxide removes significant amounts of HCN and H_2S from tobacco smoke without affecting its flavour.

- Sulfur Removal

Zinc oxide is effective in removal of Sulfur and Sulfur compounds from a variety of fluids and gases, particularly industrial flue gases. Zinc is also effective in removal of H_2S from hydrocarbon gases and for desulfurization of H_2S and certain other sulfur-containing compounds.

- Foods and Food-packaging materials

Zinc oxide and its derivatives contributing special fungi-static and chemical properties to the processing and packaging of various animal and vegetable products. In the packaging of meat, fish, corn and peas, for examples, Zinc oxide has long been incorporated into the varnish linings of the metal containers to prevent formation of black Sulfides which discolor the food.

- Fire Retardants

Zinc oxide and its derivatives were used extensively in fire retardants for the military in World War II and those zinc compounds have since been the subject of extensive research and development for preparation of fire-retardant compositions for a variety of substances. Solutions for fireproofing textiles contain zinc oxide, Boric Acid, and Ammonia in various proportions. It deposits water-insoluble Zn Borate on the fibers.

- **Ferrites**

Zinc oxide continues as an essential ingredient in the "soft" type of ferromagnetic materials for television, radio, and telecommunication applications. In these fields ferrites based on Magnetite, Nickel Oxide and Zinc Oxide are used as elements in many types of electronic devices. Numerous electronic instruments for the consumer market utilize ferrites to impart specific functions. In portable and car radios, the antenna cores are ferrites designed to provide highly selective tuning. Television picture tubes constitute a major market for ferrites, particularly for use in flyback transformers and deflection yokes. In the communications area, ferrites are extensively used in the filter inductors of telephone circuits to permit precise inductance adjustment for the purpose of separating channels. Magnetic tape for recorders is improved by use of a Magnetite precipitated in the presence of Zinc oxide.

- **Batteries, Fuel Cells, Photocells**

Zinc oxide is used in Zinc-Carbon dry cells, Zinc-Silver Oxide batteries, Nickel Oxide-Cadmium batteries and even in secondary batteries. In Fuel cells, Zinc Oxide is used as electrode material, cathodic material and as a fuel element. And in Solar Energy Cells, it can act as a photocatalyst. Purification of motorcar exhaust gases is currently the subject of extensive research, and Zinc Oxide is already demonstrating its catalytic properties in some of those programs.

- **Thermoelements**

Zinc oxide plays an important role in semiconductor ceramic elements for operation at elevated temperatures or High Voltages. Such Thermoelements can be produced to cover a broad range of thermal and electrical properties. Varistors are composed of semiconductor zinc oxide modified by other Oxides. Developed for use as lightning arrestors and high-voltage surge arrestors in electric transmission lines, they are based on a unique electronic property of semiconductor zinc oxide, nonlinear resistance. Zinc oxide varistors have high-temperature stability and resistance to humidity, electrical load, and current shocks.

- Silicate Compositions

Zinc oxide reacts with aqueous solutions of Silicates, such as Sodium Silicate solutions (commonly known as water glass) to form Zinc Silicate, a waterproof, fireproof refractory material, which is useful as a binder in paints. Such refractory adhesives are used in bonding Asbestos-cement molded products to building structures.

- Fungicides

Zinc oxide and its derivatives contribute effectively to the control of fungi in many different types of applications. Zinc oxide per se is not a fungicide; rather it is a fungistat, that is, it inhibits the growth of fungi, such as mildew on the surface of exterior house paints. This property is also used to particular advantage in the fortifying of fungicides; zinc oxide is added to fungicides to increase their effectiveness in specific applications.

- Portland Cement

The beneficial effects of zinc oxide additions to Portland cement have long been known - retardation of setting and hardening (to reduce the rate of heat evolution), improvement in whiteness and final strength.

Toxicity of Zinc oxide nanoparticles

Because zinc oxide nanoparticles are soluble in water and have antimicrobial properties, the material is listed as very toxic to aquatic organisms and as an environmental hazard. How does it work ?

• Zinc Oxide is a chemical compound that absorbs ultraviolet light (UV).

• Zinc Oxide has been used in UV protection cream for many years. Zinc oxide is a good sunscreen because it can filter UVA as well as UVB light. This provides a broader UV protection than other sunscreening chemical compounds.

• Zinc oxide particles to provide SPF protection. Zinc oxide gives excellent sun protection but is typically white so it is often not used as a sun protection product. When Zinc oxide is made into nanoparticles (less than 100nm) they become translucent leaving no white residue.

Nanoparticles also have higher surface to volume ratio. It is believed that zinc oxide nanoparticles have a greater UV absorption because of its larger surface to volume ratio making the product more effective than typical zinc oxide.

2.2 Allantonin

Allantonin = Protect irritation

This natural chemical are a high-performing skin protectant and helps with healing and has a soothing effect.

2.3 Glycerine

Glycerine = Keep moisture

Glycerol is an organic compound, also commonly called glycerin or glycerine. It is a colorless, odorless, viscous liquid that is widely used in pharmaceutical formulations. Glycerol has three hydrophilic hydroxyl groups that are responsible for its solubility in water and its hygroscopic nature. The glycerol substructure is a central component of many lipids. Glycerol is sweet-tasting and of low toxicity. The name glycerol is preferred for the pure chemical, but the commercial product is usually called glycerin. It is widely distributed in nature in the form of its esters, called glycerides. The glycerides are the principal constituents of the class of natural products known as fats and oils.

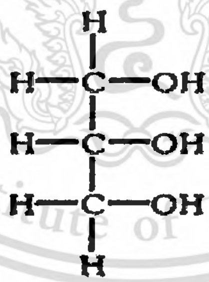


Figure 2.3.1 Structure of Glycerol

When pure, glycerin is a colorless, odorless, viscous liquid with a sweet taste. It is completely soluble in water and alcohol but is only slightly soluble in many common solvents, such as ether, ethyl acetate, and dioxane. Colorless, odorless, sweet-tasting, syrupy liquid. Glycerol is a trihydric alcohol. It melts at 17.8°C, boils with decomposition at 290°C, and is miscible with water and ethanol. It is hygroscopic; i.e., it absorbs water from the air; this property makes it valuable as a moistener in cosmetics.

Glycerin is used in nearly every industry. With dibasic acids, such as phthalic acid, it reacts to make the important class of products known as alkyd resins, which are widely used as coating and in paints. It is used in innumerable pharmaceutical and cosmetic preparations; it is an ingredient of many tinctures, elixirs, cough medicines, and anesthetics; and it is a basic medium for toothpaste. In foods, it is an important moistening agent for baked goods and is added to candies and icings to prevent crystallization. It is used as a solvent and carrier for extracts and flavoring agents and as a solvent for food colors. Many specialized lubrication problems have been solved by using glycerin or glycerin mixtures. Many millions of pounds are used each year to plasticize various materials. In foods and beverages, glycerol serves as a humectant, solvent and sweetener, and may help preserve foods. It is also used as filler in commercially prepared low-fat foods (e.g., cookies), and as a thickening agent in liqueurs. Glycerol also serves as a way, along with water, to preserve certain types of leaves. Glycerol is also used as a sugar substitute. In this regard, it has approximately 27 calories per teaspoon and is 60% as sweet as sucrose. Although it has about the same food energy as table sugar, it does not raise blood sugar levels, nor does it feed the bacteria that form plaques and cause dental cavities. As a food additive, glycerol is also known as E number E422.

In organic synthesis, glycerol is used as a readily available prochiral building block. Even if glycerol with no substitutions is symmetrical, and carbon atoms 1 and 3 are exchangeable, once one of them forms an ester or ether bond, the two are no longer exchangeable. Further bond formation and lysis may lead to products substituted solely at the third carbon; due to such circumstances, to maintain both full description and conformance to the chemistry naming rules (which require carbon counting to minimize ordinal numbers of substituents), the carbons are named *sn*-1, *sn*-2, and *sn*-3, with "sn" standing for "sterospecifical numbering"

Glycerine can also serve as a substitute for petroleum based products. Glycerin derived epichlorohydrin and propylene glycol are substitutes for petroleum-based Polypropylene.

2.4 Polyglykol-6000

Polyglykol-6000 = Give moisture for skin (make soft skin)

A dihydroxy ether derived from the dehydration (removal of a water molecule) of two or more glycol molecules.

2.5 Aristoflex AVC (Ammonium Acryloyldimethyltaurate)

Aristoflex AVC = make the solution to be cream

Ammonium acryloyldimethyltaurate(Aristoflex AVC) is a novel synthetic polymeric sulfonic acid used as a rheology modifier for aqueous and solvent containing systems and as a texturizer/stabilizer for oil-in-water systems. O/W emulsions may be formulated either by combining the polymer with conventional emulsifiers or by using it as the sole stabilizer to create surfactant-free systems known as cream gels. Aristoflex AVC is made by copolymerization of acryloyldimethyltaurate (often called AMPS) and vinylpyrrolidone in the presence of ammonia. Aristoflex AVC is easy to use, as the polymer is pre-neutralized. Gelling takes place immediately when the polymer comes in contact with water. Three different ways of incorporating the polymer into O/W systems are possible. It may be predispersed in the oil phase before the water phase is added, it may be incorporated into the water phase or it may be added as the last component after water and oil phases have been combined. Characteristics which are of particular interest to the cosmetics formulator include: insensitivity to pH over the pH 4 - 9 range , stability against degradation by high shear, stability towards UV light and compatibility with polar organic solvents. Cream gels based on Ammonium Acryloyldimethyltaurate/VP Copolymer break differently on the skin, opening doors to novel galenic forms with new sensory properties. A special feature of Aristoflex AVC is its ability to stabilize O/W emulsions that do not contain surfactant emulsifiers. We call these formulations cream gels.

2.6 AP wax 80 (Polyethylene Glycol Stearate /Cetostearyl Alcohol)

AP wax 80 = make solution to be cream

AP wax 80 is a mixture of fatty alcohols, consisting predominantly of cetyl and stearyl alcohols and is classified as a fatty alcohol. It is used as an emulsion stabilizer, opacifying agent, and foam boosting surfactant, as well as an aqueous and nonaqueous viscosity-increasing agent. It imparts an emollient feel to the skin and can be used in water-in-oil emulsions, oil-in-water emulsions, and anhydrous formulations. It is commonly used in hair conditioners and other hair products.

2.7 Hostaphat KL 340 D (Trilaureth- 4 Phosphate)

Hostaphat KL 340 D (Trilaureth- 4 Phosphate) = mixed water to oil

Originally : Tri(laureth-4)-phosphate : $[C_{12}H_{25}(OC_2H_4)_3O]_3PO$

It is a surfactant and emulsifier. Trilaureth-4-phosphate is a synonym for a compound known as Sodium POE (10) Lauryl Ether Phosphate which has a CAS Registry No. of 42612-52-2. This surfactant is typically available as a pale yellow paste. It can be used as a solubilizer for perfumes; also to improve texture of skin lotions and tonics among other applications.

2.8 Emulsogen HCO 040 (PEG-40 Hydrogenated Castor Oil)

Emulsogen HCO 040 = mixed water to oil

Emulsogen HCO 040 are polyethylene glycol derivatives of castor oil. PEG-40 Hydrogenated Castor Oil are polyethylene glycol derivatives of hydrogenated castor oil. PEG-40 Castor Oil is an amber-colored liquid. PEG Castor Oils and PEG Hydrogenated Castor Oils are used in the formulation of a wide variety of cosmetics and personal care products PEG Castor Oils and PEG Hydrogenated Castor Oils that have been studied to all the ingredients in the family. No dermal or ocular irritation was observed following exposure to the PEG Castor Oil and PEG Hydrogenated Castor Oil ingredients. In studies using up to 50% PEG-35 Castor Oil, irritation was seen when this ingredient was placed on the skin, but no sensitization was found on challenge. This ingredient was found to increase the sensitization potential of other ingredients. No evidence of developmental toxicity was seen in feeding studies. Small amounts of 1,4-dioxane, a by-product of ethoxylation, may be found in the PEG Castor Oil and PEG Hydrogenated Castor Oil ingredients. The potential presence of this material is well known and can be controlled through purification steps to remove it from the ingredients before blending into cosmetic formulations.

2.9 HEST GTO (Triethyl Hexanoin)

HEST GTO (Triethyl Hexanoin) = Solvent /Give moisture

Triethylhexanoin is a glyceryl triester, or triglyceride, derived from glycerin and fatty acids. It is a relatively pure fat which differs only slightly from the fats and oils found in nature, primarily animal and vegetable fats and oils such as tallow, palm-nut and coconut oils. Triethylhxanoin is a versatile ingredient and is used as a skin conditioning agent, emollient, anti-static agent, solvent, and fragrance ingredient in cosmetics and personal care products, including make up, creams and lotions, deodorants, suntan and sunscreen products, hair conditioners, and skin care and skin cleansing products. There is little specific information available regarding Triethylhexanoin, and the Cosmetics Database classifies it as a low hazard ingredient but notes 100% data gaps. According to research done by the CIR (but not corroborated independently), Triethylhexanoin is not absorbed by the skin, not irritating, not a sensitizer. "metabolism data indicated that glyceryl triesters followed the same metabolic pathways as fats in food. They were split into monoglycerides, free fatty acids, and glycerol. All of which were absorbed into the intestinal mucosa and metabolized further. Therefore, oral exposure to these compounds was not a concern."

2.10 P-4-O (Pentaerythrityl tetraoctanoate)

P-4-O = Help to get smooth skin

P-4-O is clear liquid, light, make skin smooth and give moisture for skin used to make sunscreen and not make irritation.

Origin : Synthetic compound derived from fatty acids.

Function : Emollient / Moisturiser / Viscosity adjuster

2.11 Jojoba Oil

Jojoba Oil = Give Moisture

Jojoba oil is the liquid wax produced in the seed of the jojoba (Simmondsia chinensis) plant, a shrub native to southern Arizona, southern California and northwestern Mexico. The oil makes up approximately 50% of the jojoba seed by weight Jojoba oil is a mixture of wax esters, 36 to 46 carbon atoms in length. Each molecule consists of a fatty acid and a fatty alcohol joined by an ester bond. 98% of the fatty acid molecules are unsaturated at the 9th carbon-carbon bond (omega-9). The approximate percentages of fatty acids in jojoba oil are as follows :

Fatty acid	Min	Max
Eicosenoic	66%	71%
Docosenoic	14%	20%
Oleic	10%	13%

Unlike common vegetable oils, jojoba oil is chemically very similar to human sebum. Most jojoba oil is consumed as an ingredient in cosmetics and personal care products, especially skin care and hair care. Jojoba derivatives, including jojoba esters, isopropyl jojobate and jojoba alcohol, are particularly widely used in this context. Jojoba oil is also used as a replacement for whale oil and its derivatives, such as cetyl alcohol. The ban on importing whale oil to the US in 1971 led to the discovery that it is "in many regards superior to sperm oil for applications in the cosmetics and other industries."

2.12 DC-345

DC-345 (Cyclomethicone) = Help to get smooth skin

Cyclomethicone is a clear, odorless, silicone-based oil that is incredibly useful and versatile in a number of bath & body recipes. It is a synthetic unmodified silicone that stays on the surface of the skin, the molecules are too big to physically enter past the upper living cells. Cyclomethicone is used as a base solvent to blend with fragrance oils and perfume oils. Cyclomethicone is a clear, odorless silicone. It leaves a silky-smooth feel when sprayed on the skin. Ideal for body sprays, lotions creams, bath salts, hair care, linen sprays etc. Cyclomethicone stays completely blended and crystal clear without shaking. Cyclomethicones are unmodified silicones that possess a cyclical structure rather than the chain structures of dimethyl silicones. Low heat of vaporization and the ability to select a desired vapor pressure has led their use as cosmetic vehicles. Unmodified silicones stay on or near the surface of the skin. Not only are the molecules too big to physically enter past the upper living cells, they associate with the upper layer of drying skin but they also cannot penetrate cell membranes due to their large size. Cyclomethicones evaporate quickly after helping to carry oils into the top layer of epidermis. From there, they may be absorbed by the skin. Cyclomethicones perform a similar function in hair care products by helping nutrients enter the hair shaft.

2.13 TS-10 (Titanium Dioxide Treated silica)

TS-10 (Titanium Dioxide Treated silica) = Sunscreen/Absorb oiliness

Titanium dioxide, also known as titanium(IV) oxide or titania, is the naturally occurring oxide of titanium, chemical formula TiO_2. When used as a pigment, it is called titanium white, Pigment White 6, or CI 77891. Titanium dioxide occurs in nature as well-known minerals rutile, anatase and brookite, and additionally as two high pressure forms, a monoclinic baddeleyite-like form and an orthorhombic α-PbO_2-like form, both found recently at the Ries crater in Bavaria. The most common form is rutile, which is also the most stable form. Anatase and brookite both convert to rutile upon heating. Rutile, anatase and brookite all contain six coordinated titanium. Titanium dioxide has eight modifications - in addition to rutile, anatase and brookite there are three metastable forms produced synthetically (monoclinic, tetragonal and orthorombic), and five high pressure forms (α-PbO_2-like, baddeleyite-like and cotunnite-like) :

Table 2.13 the structure of Titanium Dioxide

Form	Crystal system	Synthesis
rutile	tetragonal	
anatase	tetragonal	
brookite	orthorhombic	
TiO_2(B)	monoclinic	Hydrolysis of $K_2Ti_4O_9$ followed by heating
TiO_2(H), hollandite-like form	tetragonal	Oxidation of the related potassium titanate bronze, $K_{0.25}TiO_2$
TiO_2(R), ramsdellite-like form	orthorhombic	Oxidation of the related lithium titanate bronze $Li_{0.5}TiO_2$
TiO_2(II)-(α-PbO_2-like form)	orthorhombic	
baddeleyite-like form, (7 coordinated Ti)	monoclinic	
TiO_2 -OI	orthorhombic	
cubic form	cubic	
TiO_2 -OII, cotunnite($PbCl_2$)-like	orthorhombic	

The naturally occurring oxides can be mined and serve as a source for commercial titanium. The metal can also be mined from other minerals such as ilmenite or leucoxene ores, or one of the purest forms, rutile beach sand. Star sapphires and rubies get their asterism from rutile impurities present in them. Titanium dioxide is the most widely used white pigment because of its brightness and very high refractive index (n = 2.7), in which it is surpassed only by a few other materials. Approximately 4 million tons of pigmentary TiO_2 are consumed annually worldwide. When deposited as a thin film, its refractive index and colour make it an excellent reflective optical coating for dielectric mirrors and some gemstones, for example "mystic fire topaz". TiO_2 is also an effective opacifier in powder form, where it is employed as a pigment to provide whiteness and opacity to products such as paints, coatings, plastics, papers, inks, foods, medicines (i.e. pills and tablets) as well as most toothpastes. Opacity is improved by optimal sizing of the titanium dioxide particles.

2.14 Benzophenone3

Benzophenone3 (Oxybenzone) = Sunscreen

Benzophenone3 is an organic compound used in sunscreens. It is a derivative of benzophenone. It forms colorless crystals that are readily soluble in most organic solvents. A 2008 study by the US Centers for Disease Control and Prevention found the compound to be present in 96.8% of human urine samples analyzed as part of the National Health and Nutrition Examination Survey. It is used as an ingredient in sunscreen and other cosmetics because it absorbs UVB and short-wave UVA (ultraviolet) rays. In the EU products intended for skin protection with 0.5% or more oxybenzone must be labeled "Contains Oxybenzone".

2.15 OMC (Octyl Methoxycinamate)

OMC = Sunscreen

OMC is an organic compound that is an ingredient in some sunscreens and lip balms. It is an ester formed from methoxycinnamic acid and 2-ethylhexanol. It is a clear liquid that is insoluble in water. Its primary use is in UV protection cream and other cosmetics to absorb UV-B rays from the sun, protecting the skin from damage. It is also used to reduce the appearance of scars.

SPF (Sun Protection Factor)

SPF, or Sun Protection Factor, is a measurement of how well a sunscreen will protect skin from UVB rays, the kind of radiation that causes sunburn and is thought to contribute to some types of skin cancer. The SPF rating only tells you only about UVB protection, not about harmful UVA rays. UVA is the wavelength of sunlight that penetrates deeper into the skin without causing surface burning, but has the potential to release free radicals and perhaps cause skin melanoma and photo aging. Always choose sun protection that is broad spectrum - blocks both UVB and UVA wavelengths. Just because a sunscreen has a high SPF, it does not mean you are being protected from damaging UVA rays.

Time spend in the sun before you get burn : SPF rating = time of protection you get from your sunscreen

UVA : Long-wave solar rays of 320-400 nm. Penetrate the skin more deeply (into the Dermis, 2nd layer of skin); cause photo aging, actinic damage (wrinkled, leathery, variously pigmented skin); and can contribute to skin cancers including melanoma. Rays are the same strength year-round.

UVB : Short-Wave solar rays of 290-320 nm. Penetrate only the epidermis; cause sunburn; and considered to be the main cause of basal and squamous cell carcinomas, as well as a significant factor in melanomas. Different strengths depending on Sun's location, and can be lessened when deflected by clouds.

UVC : Reflected by the Ozone layer, does not reach the Earth.

Toxicity of UV protection cream

Skin

No UV protection cream should be used on children during the first six months of life. UV protection cream that contain aminobenzoic acid and its esters (PABA), cinnamates, and oxybenzone can cause a skin rash and allergic photosensitivities but this is uncommon. In May 1988, a new nitrosamine known as NPABAO was found in certain UV protection cream containing padimate-O as the active ingredient. Nitrosamines themselves can be carcinogenic, however, at this time it is uncertain whether this nitrosamine is present in sufficient quantities in UV protection cream to be of concern. Miscellaneous compounds, such as fragrances, lanolin, alcohol, and preservatives may also cause skin and eye irritation or sensitization. If Swallowed Symptoms are unlikely with normal childhood exposure. Stomach irritation and nausea are the most common symptoms. Since PABA sunscreens contain 50 percent or more ethanol, ethanol toxicity may be the greater risk. Many UV protection products contain a form of an aspirin-like substance (salicylate) as their active ingredient. For example, homomenthyl salicylate (homosalate) is a UV protection cream agent found in many Coppertone products. Theoretically, homosalate-containing UV protection cream ingested in substantial amounts may cause aspirin (salicylate) poisoning; however, there are no such reported cases of salicylate intoxication.

Toxicity of zinc oxide nanoparticles and titanium dioxide nanoparticles

The primary toxicity concern of nanoparticles is damage caused by free radical generation, which can provoke intense oxidative stress, inflammation and cell damage. All sunscreen chemicals provoke a degree of oxidative stress, but nano-size titanium dioxide and zinc oxide have been shown to be more potent than conventional size particles in laboratory tests. Interestingly, the level of oxidative damages caused by several types of nano-size titanium is minimal compared to the amount generated by UV radiation on bare skin underscoring the importance of comparing UV filters to each other and to the effects of sunlight on unprotected skin. The exact particle size and surface coatings of nanoparticles affect reactivity. The anataste form of titanium is much more reactive than the rutile form, whether it be to oxidize the paint on steel roofs or generate cellular stresses in skin cells. Titanium dioxide and zinc oxide nanoparticles used in sunscreen are commonly coated - titanium with magnesium, silica, alumina or zirconium and zinc with dimethicone. Coatings greatly reduce or eliminate the UV reactivity of titanium nanoparticles. In a study of 3 types of titanium nanoparticles, researchers found that uncoated anatase and rutile titanium caused cell damage and oxidative stress, while particles with polymer coatings did not (Pan 2009). Despite this, both zinc and titanium dioxide, including forms extracted from UV protection cream, have been shown to provoke oxidative stress and a variety of cell damage. Some forms of titanium dioxide are more reactive when catalyzed by UV light, though other studies report no UV-catalyzed damages. Zinc is generally less reactive than titanium, and also appears to be less catalyzed by UV exposure (Dufour 2006). However, a recent study exposing epidermal cells found markers of oxidative stress and DNA damage after exposure to uncoated zinc oxide nanoparticles. The particle size was generally 30 nm, which aggregated into clusters about 165 nm in diameter (Sharma 2009). This study indicates than zinc oxide nanoparticles could have toxic effects in the absence of skin penetration. The NanoDerm project tested the toxicity of nano-scale titanium dioxide to skin cells and found a variety of impacts to cell viability, proliferation, apoptosis and differentiation. Fibroblasts and melanocytes took up titanium, which resulted in altered calcium levels, a key regulator of cell mechanisms in these types of cells. Titanium also reduced cell growth in all cell types and induced apoptosis in some cells. These and other effects noted may result in abnormal barrier function of skin cells. These impacts were deemed of minimal concern for sunscreen products given the conclusion by the same group that titanium nanoparticles do not penetrate to living tissues. Nevertheless, researchers raised cautions about the application of nano-scale titanium to broken or psoriatic skin where it might have direct access to living tissues. Scientists seeking to study nanoparticles behavior and toxicity have injected nanoparticles directly into test. These studies examine worst-case exposures to high doses of nanoparticles in the bloodstream. Titanium particles have been found to accumulate in the liver, kidneys, spleen, lung, brain and heart. Particles can also penetrate the reproductive organs and developing fetus causing reproductive and brain disturbances in offspring.

Chapter 3

Experimental Details

3.1 Preparation of nano zinc oxide UV protection creams

3.1.1 Chemicals

1. Allantoin

2. Glycerine

3. Polyglykol-6000

4. Aristoflex AVC

5. AP wax 80

6. Hostaphat KL 340 D (Trilaureth- 4 Phosphate)

7. Emulsogen HCO 040 (PEG-40 Hydrogenated Castor Oil)

8. HEST GTO (Triethyl Hexanoin)

9. P-4-O (Pentaerythrityl tetraoctanoate)

10. Jojobar Oil

11. DC-345 (Cyclomethicone)

12. TS-10

13. Nano Zinc Oxide

14. Benzophenone 3 (also known as oxybenzone)

15. OMC (Octyl Methoxycinamate)

16. Citric acid

17. water, distilled or deionized

3.1.2 Instruments

1. Beaker, 50 mL, 100 mL, 150 mL, 500 mL

2. Thermometer

3. Homogenizer (or mechanical stirrer)

4. Water bath

5. Heater

6. Glass stirring rod

3.1.3 Procedure

Weigh the quantities of DI water, allantoin, glycerine and polyglykol-6000 called for in assigned formulation from Table 1 (part 1) into the beaker. Heat the mixture of part 1 in a water bath until the mixture have melted, temperature about 40-50 °C. After the water solution has reached a temperature between 40°C and 50°C, remove it from the heat. Then Weigh the quantities of Aristoflex AVC (part 2) to the beaker and heat the mixture until the ingredients have melted to a temperature about 60-70 °C. Remove the melted Aristoflex AVC from the heat and slowly pour the melted Aristoflex AVC to mixed with the mixture ingredients (part 1). Stir constantly. Then weigh the quantities of AP wax 80 (part 3) and slowly add its to the mixture ingredients of part 1 and part 2. Stir constantly until have a smooth, uniform paste. After that cooled down a smooth cream to temperature of 40-50 °C, then weigh ingredients in part 4 (Hostaphat KL 340 D, Emulsogen HCO 040, HEST GTO, P-4-O, jojoba oil, DC 345, TS-10, Zinc Oxide nanoparticles, Benzophenone 3, OMC and citric acid), add to the mixture. Stirring until begin the smooth UV protection cream.

Table 3.1.3 the components of nano zinc oxide UV protection cream

Part	Ingradients	Formulation no.1	Formulation no.2	Formulation no.3	Formulation no.4	Formulation no.5	Formulation micronized ZnO
Part 1	- DI water	38%	38%	38%	38%	38%	38%
	- Allantoin	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%
	- Glycerine	3.20%	3.20%	3.20%	3.20%	3.20%	3.20%
	- Polyglykol-6000	2%	2%	2%	2%	2%	2%
Part 2	- Aristoflex AVC	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%
Part 3	- AP wax 80	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%
Part 4	- Hostaphat KL 340 D	6%	6%	6%	6%	6%	6%
	- Emulsogen HCO 040	3%	3%	3%	3%	3%	3%
	- HEST GTO	12%	12%	12%	12%	12%	12%
	- P-4-O	3%	3%	3%	3%	3%	3%
	- Jojobar Oil	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%
	- DC 345	3%	3%	3%	3%	3%	3%
	- TS-10	9%	8%	7%	6%	5%	-
	- Nano Zinc Oxide	1%	2%	3%	4%	5%	10%
	- Benzophenone 3	5%	5%	5%	5%	5%	5%
	- OMC	7%	7%	7%	7%	7%	7%
	- Citric acid	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%

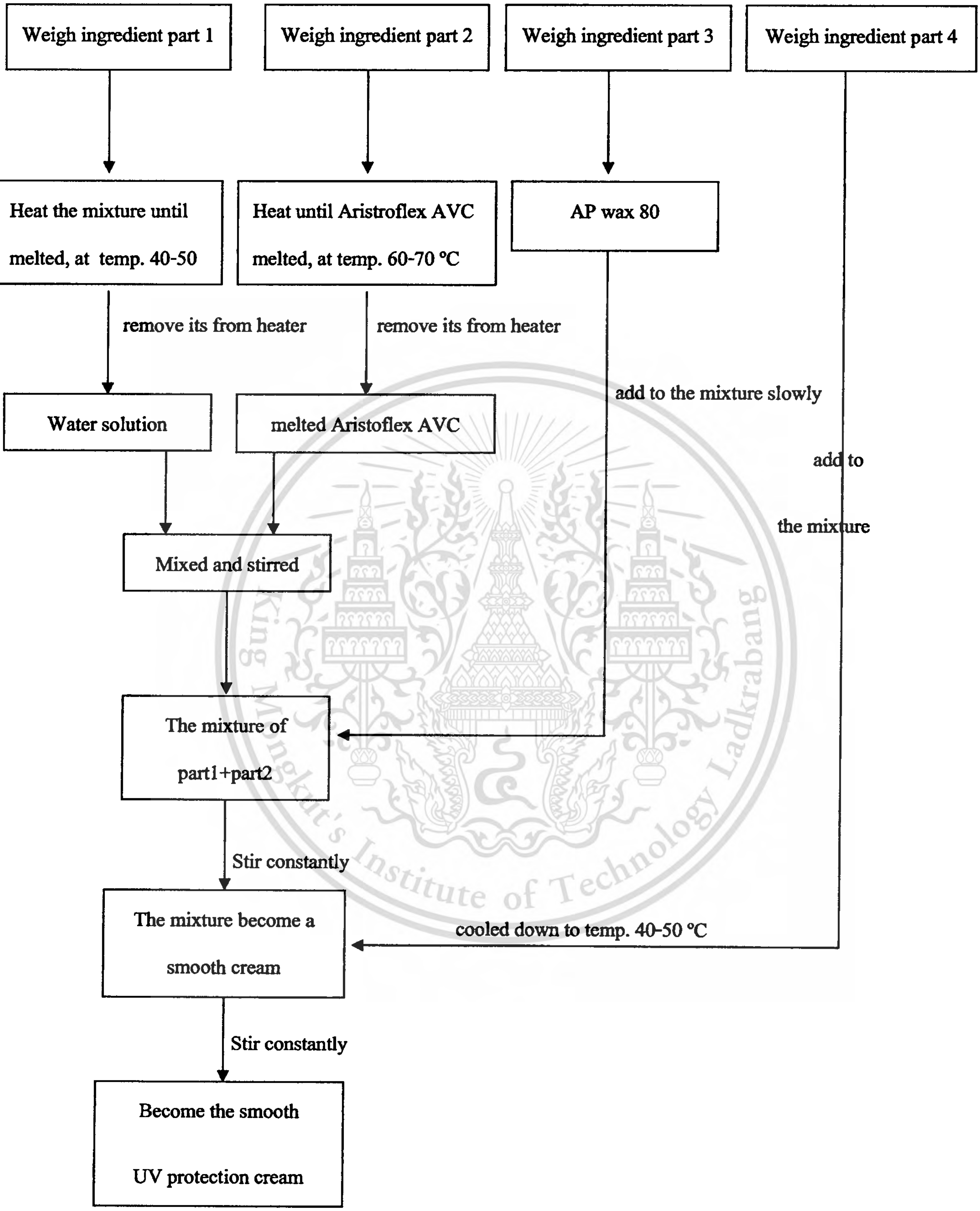


Figure 3.1.3 Preparation of nano zinc oxide UV protection cream

3.2 Evaluation of UV protection cream

3.2.1 chemicals

1. UV protection cream, prepared in Part I of this experiment

2. Commercial UV protection cream

3. iso-proply alcohol

3.2.2 Instruments

1. beakers, 100 mL

2. glass stirring rods

3. cuvettes for the spectrophotometer

4. test tubes

5. UV-VISIBLE Spectrophotometer (Shimadzu UV-160A)

6. Optometrics LLC SPF-290S, in vitro method (tested at Cosmetics and Natural Products Research Center)

Procedure

1.UV-VISIBLE Spectrophotometer (Shimadzu UV-160A) should be turned on, set to 400 nm, and allowed to warm up for 15 minutes.

2. Prepare a 0.10% solution (w/v) of your assigned commercial UV protection cream in iso-propyl alcohol.

3. Weigh 0.050 g of UV protection cream into a 100 mL beaker. Add 50.0 mL of iso-propyl alcohol and stir to dissolve the lotion. Label the solution with the brand name of the UV protection cream and its SPF rating. Following the same procedure, prepare a second 0.10% solution of the UV protection cream you prepared in the laboratory in iso-proply alcohol.

4. Fill a cuvette approximately ¾ full with the 0.10% solution of the commercial UV protection cream. Record the brand name and SPF rating of the sunscreen. You may label the cuvette near the top using a waterproof marker or small piece of laboratory tape.

5. Fill a second cuvette ¾ full with the 0.10% solution of the laboratory prepared sunscreen lotion. This is your blank solution. You may label the cuvette near the top using a waterproof marker or small piece of laboratory tape.

6. Fill a third cuvette ¾ full with iso-propyl alcohol. This is your blank solution. You may label the cuvette near the top using a waterproof marker or small piece of laboratory tape.

7. Place the cuvette with the iso-propyl alcohol in the cuvette holder of the UV-VISIBLE Spectrophotometer (Shimadzu UV-160A) and close the cell compartment cover. Zero the instrument.

8. Remove the blank and insert the cuvette containing the commercial UV protection solution sample. Record the absorbance at 400 nm.

9. Remove the UV protection solution sample, and insert the cuvette containing solution of the laboratory prepared UV protection cream. Record the absorbance at 400 nm.

10. Remove the UV protection solution sample. Change the wavelength reading of the UV-VISIBLE Spectrophotometer (Shimadzu UV-160A) to 390 nm. Place the blank in the sample holder, close the cover, and zero the instrument.

11. Remove the blank and insert each of the cuvettes containing the UV protection solution samples. Record the absorbance at 390 nm.

12. Continue to take readings at 10 nm intervals to 320 nm. Remember to zero the instrument using the blank solution at every wavelength before reading the UV protection absorbance.

13. After collecting all the data, plot graph the absorbance vs. the wavelength for each UV protection cream sample.

Chapter 4

Result and Discussion

To demonstrate the analysis of UV protection creams, ten different types of UV protection cream samples were selected from laboratory preparation and commercial on the market.

Brand of UV protection cream and SPF used :

4.1 Laboratory prepared UV protection cream

Laboratory prepared UV protection cream

Formulation no.1	Zinc oxide nanoparticles 1%	mass used : 0.05 g
Formulation no.2	Zinc oxide nanoparticles 2%	mass used : 0.05 g
Formulation no.3	Zinc oxide nanoparticles 3%	mass used : 0.05 g
Formulation no.4	Zinc oxide nanoparticles 4%	mass used : 0.05 g
Formulation no.5	Zinc oxide nanoparticles 5%	mass used : 0.05 g
Micronized ZnO	Micronized Zinc oxide 10%	mass used : 0.05 g

4.2 The commercial UV protection cream

The commercial UV protection cream

ORIENTAL PRINCESS	SPF 30	mass used : 0.05 g
NIVEA	SPF 30	mass used : 0.05 g
BANANA BOAT	SPF 30	mass used : 0.05 g
SUIHONG	SPF 60	mass used : 0.05 g

Table 4.1 the absorbance in each wavelength measurement between 320 nm. to 400 nm.

Wavelength	Absorbance (nm)									
nm	no.1 nano ZnO	no.2 nano ZnO	no.3 nano ZnO	no.4 nano ZnO	no.5 nano ZnO	Micronized ZnO	Lotion 1 SuiHong	Lotion 2 Oriental Princess	Lotion 3 Nivea	Lotion 4 Banana Boat
400	0.07	0.067	0.087	0.089	0.146	0.075	0.006	0.087	0.123	0.094
390	0.072	0.07	0.091	0.09	0.178	0.086	0.01	0.209	0.736	0.181
380	0.076	0.072	0.101	0.091	0.188	0.12	0.003	0.596	2.572	0.474
370	0.094	0.068	0.13	0.094	0.21	0.159	0.001	0.732	2.572	1.347
360	0.149	0.078	0.213	0.108	0.343	0.289	0.00	0.65	2.572	2.572
350	2.572	2.572	2.572	2.572	2.572	2.572	0.00	2.572	2.572	2.572
340	2.572	2.572	2.572	2.572	2.572	2.572	0.00	1.338	2.572	2.572
330	1.606	1.504	2.329	2.548	2.572	2.572	0.00	0.003	2.572	2.572
320	1.287	1.171	1.502	2.572	2.572	2.572	0.00	0.00	1.551	2.572

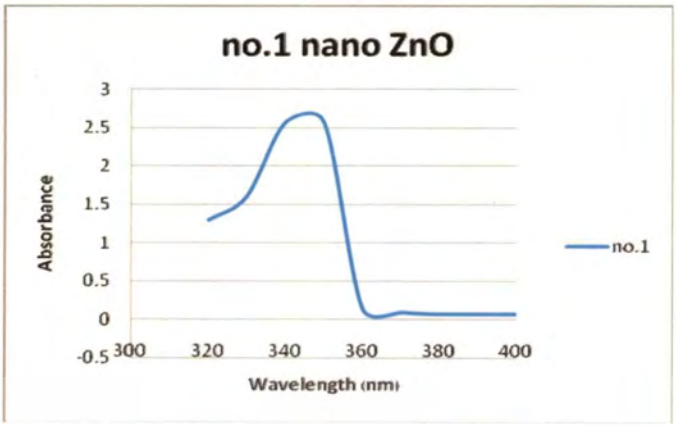


Figure 4.1.1 the absorbance of no.1 nano ZnO

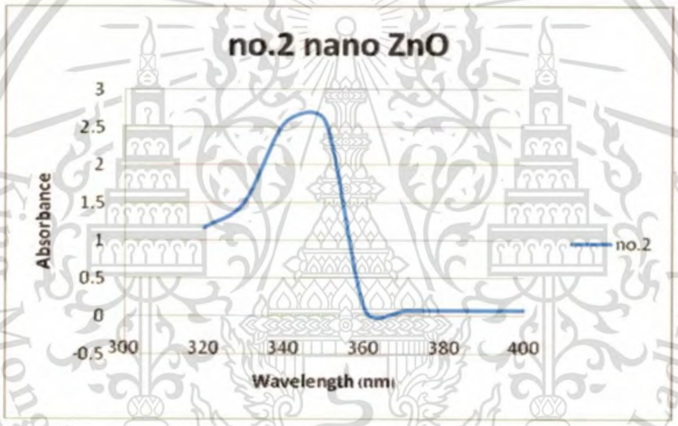


Figure 4.1.2 the absorbance of no.2 nano ZnO

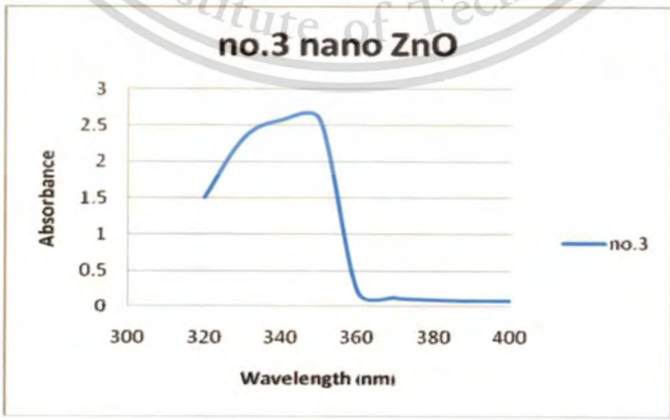


Figure 4.1.3 the absorbance of no.3 nano ZnO

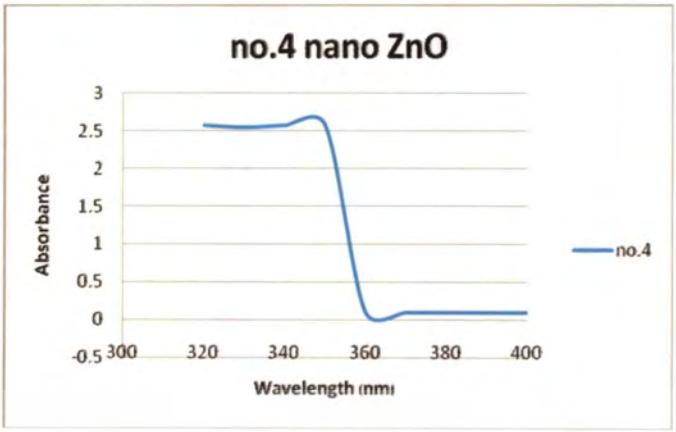


Figure 4.1.4 the absorbance of no.4 nano ZnO

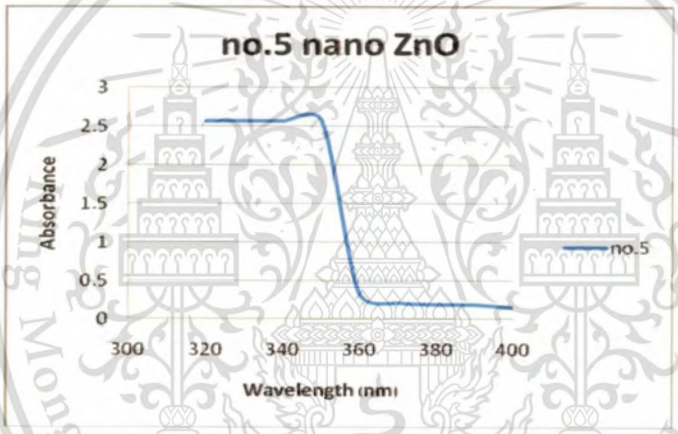


Figure 4.1.5 the absorbance of no.5 nano ZnO

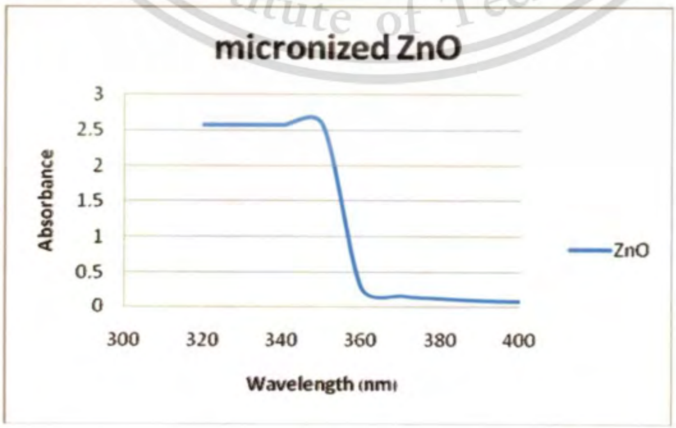


Figure 4.1.6 the absorbance of micronized ZnO

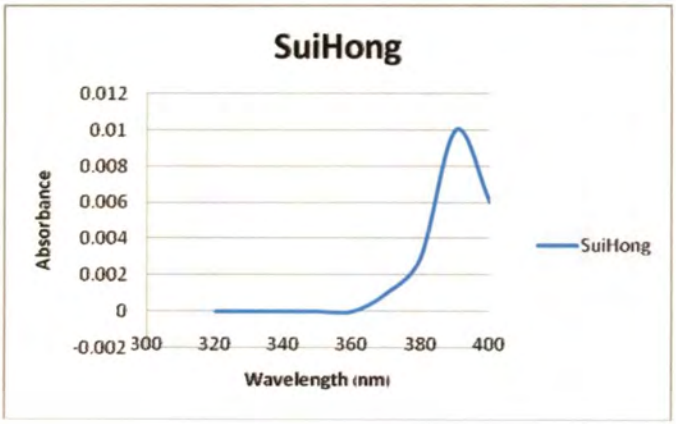


Figure 4.1.7 showed the absorbance of comercial UV protection cream Suihong

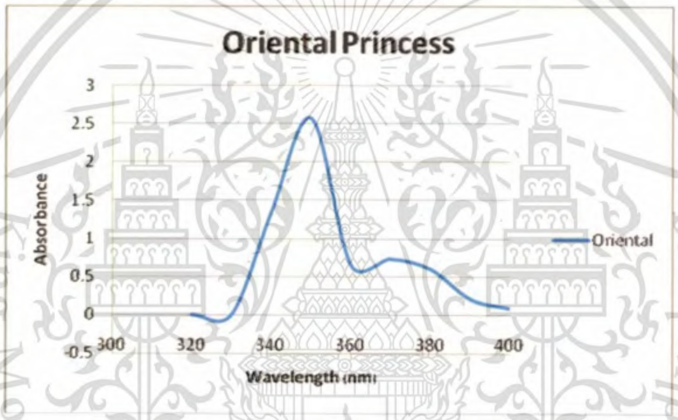


Figure 4.1.8 showed the absorbance of comercial UV protection cream Oriental Princess

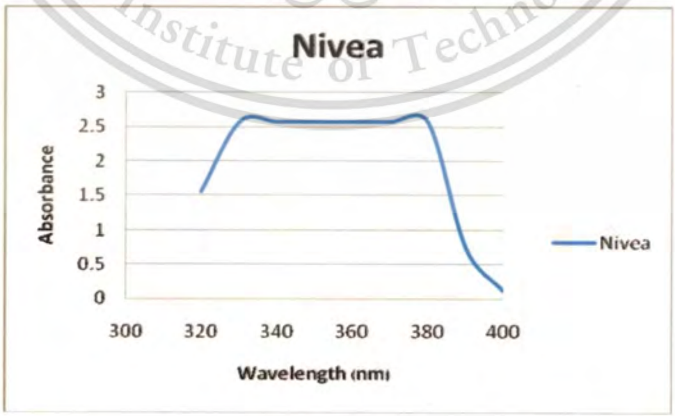


Figure 4.1.9 showed the absorbance of comercial UV protection cream NIVEA

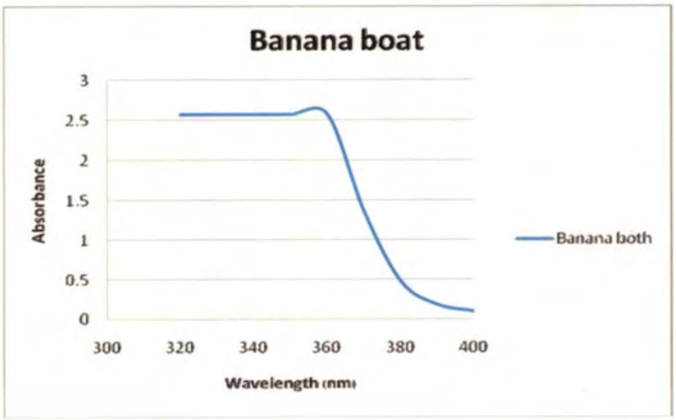


Figure 4.1.10 showed the absorbance of comercial UV protection cream Banana Boat

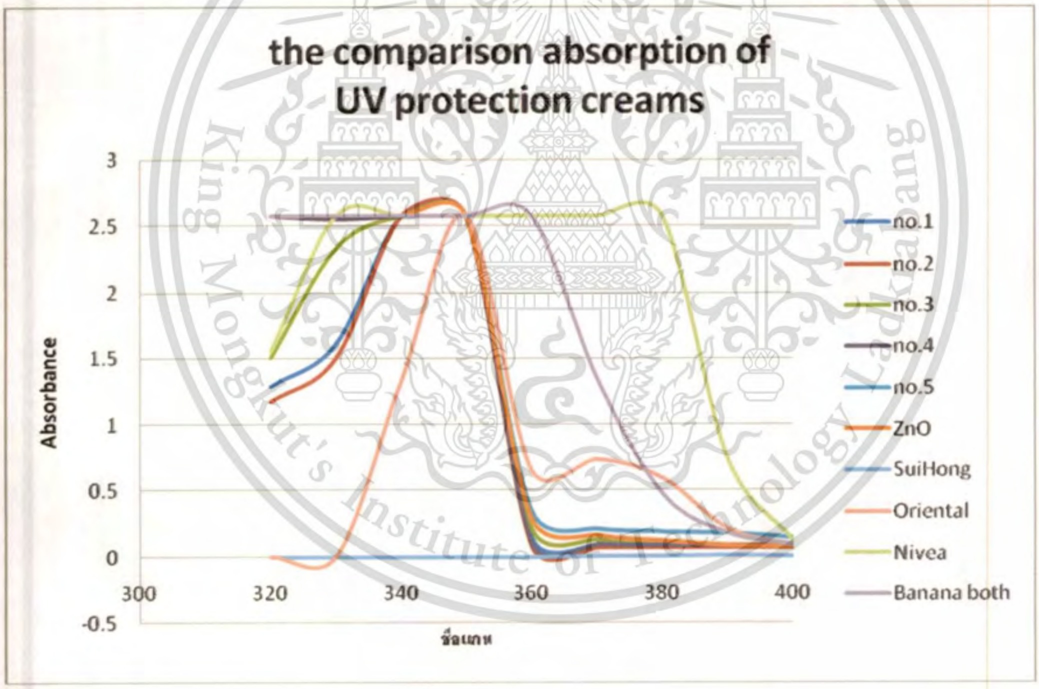


Figure 4.1.11 the comparison absorption of UV protection creams

ศูนย์วิจัยเครื่องสำอางและผลิตภัณฑ์ธรรมชาติ

โดยความร่วมมือระหว่างคณะแพทยศาสตร์ และคณะเภสัชศาสตร์
มหาวิทยาลัยนเรศวร จังหวัดพิษณุโลก
โทร – แฟกซ์ 0-5596-5238

24/03/2553

เรื่อง : ผลการตรวจวิเคราะห์ค่า SPF

เรียน : Nano Zinc Oxide for UV Protection cream Project

ผลการตรวจวิเคราะห์ค่า Sun Protection Factor (SPF)

ชื่อตัวอย่าง	Lot. No.	วันผลิต	จำนวนตัวอย่าง	ลักษณะ	ค่า SPF ที่วัดได้
Nano Zinc Oxide UV Protection Cream	-	12/03/53	50 กรัม	ครีมสีขาว	67.49 ± 1.62 *

หมายเหตุ * ความเที่ยงตรงของผลการทดสอบ SPF รับรองในช่วงไม่เกิน 50 เท่านั้น
(Only SPF upto 50 is considered accurate)

ลงชื่อ ....พ ศิดิคุณ....
(นายพิเชษฐ์ กิติคุณ)
ผู้วิเคราะห์
วันที่ ..24/..มี.ค./..2553.

ลงชื่อ ....ทัศนา พิทักษ์สุธีพงศ์....
(รองศาสตราจารย์ ดร.ทัศนา พิทักษ์สุธีพงศ์)
ผู้ควบคุม
วันที่..24../..มี.ค../..53....

ผลการวิเคราะห์นี้รับรอง
เฉพาะตัวอย่างที่ได้วิเคราะห์เท่านั้น

ห้ามใช้เพื่อการโฆษณา

ลงชื่อ ....
(รองศาสตราจารย์ ดร.เนติ วระนุช)
หัวหน้าศูนย์วิจัยเครื่องสำอางและผลิตภัณฑ์ธรรมชาติ
วันที่......../........../..........

SPF-290 Graph Report

Optometrics LLC

Measurement Information

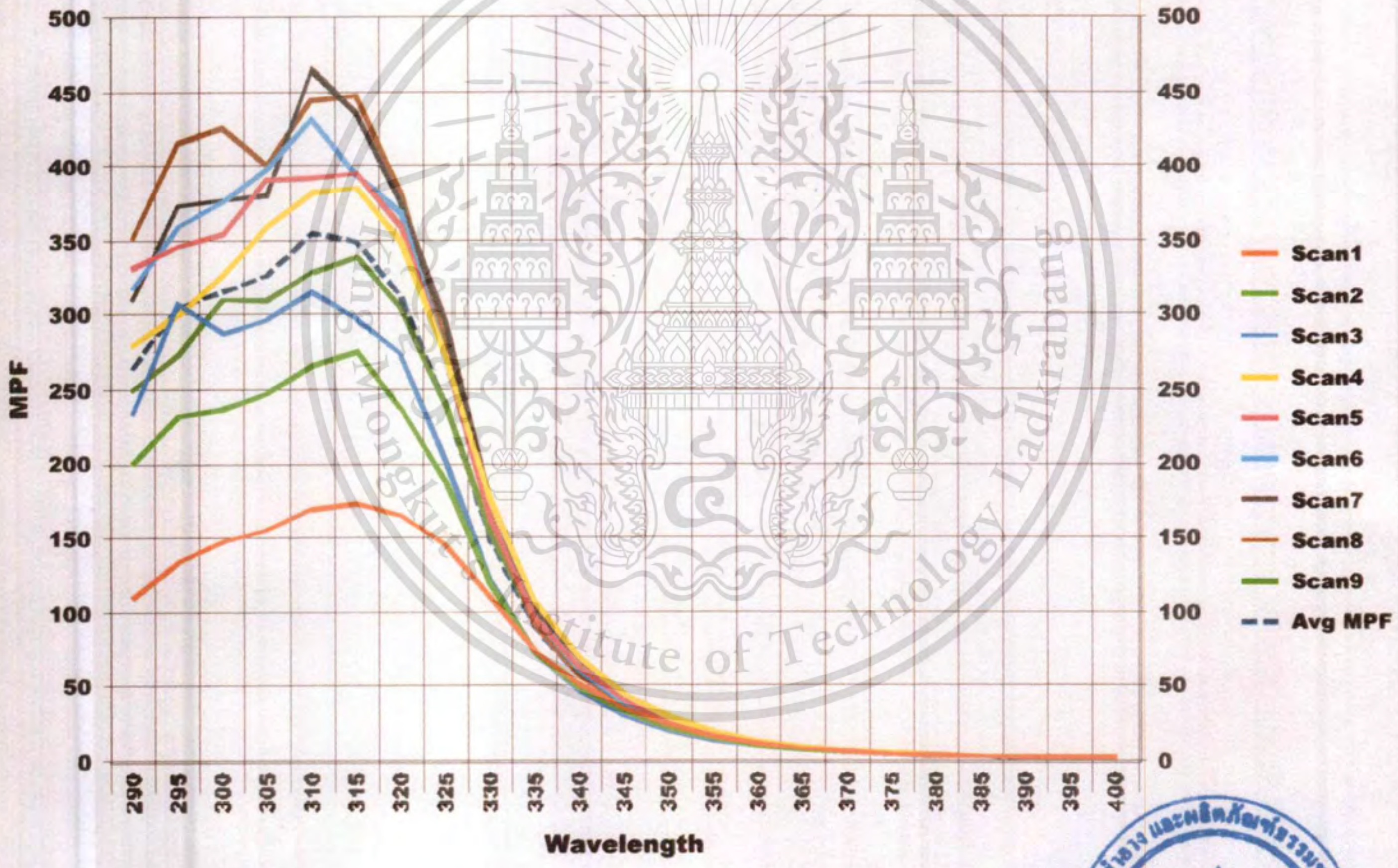
Date:	19/3/2553	Substrate:	Transpore	Sample Name:	Nano Zinc Oxide 07
Time:	16:05:17	Sample Prep.	2 mg/cm^2	Setup Filename:	Temp.par
Operator:	Pichet	Num. of Scans:	9	Data Filename:	Nano Zinc Oxide 07.spf
Wavelength Range:	290 to 400			Solar Filename:	sp40n20z.sol
Measurement Standard:	US FDA			Erythema Filename	erythema.act

Summary Results

	Value	STDV
Solar Protection Factor:	67.46	1.62
UVA/UVB ratio:	.459	.02
Star Rating:	2	
Average UVA PF:	56.59	10.26
Erythemal UVA PF:	16.09	.76
Critical Wavelength:	364.2	.74
Curve Area:	165.93	6.51

Measurement Parameters

Parameter	Value
SPF STDV:	Diffey
Excluded Runs/Scans:	
Operating Mode:	Standard
Assay STDV:	N/A
Assay Skip Ref:	N/A
Time-Based Mode:	N/A
Time-Based Delay:	N/A



mments

ผลการวิเคราะห์นี้รับรอง
เฉพาะตัวอย่างที่ได้วิเคราะห์เท่านั้น

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Chapter 5

Conclusion

The data for determining sun protection factors (SPF) and board spectrum protection classification of nano zinc oxide UV protection creams can be obtained by using the UV-VISIBLE Spectrophotometer (Shimadzu UV-160A) and determines the sun protection factor by using the Optometric LLC SPF-290S. This technic is called in-vitro test. The result of nano zinc oxide UV protection cream can measure sun protection factor as 67.49 ± 1.62 . When compared nano zinc oxide UV protection cream, micronized zinc oxide UV protection cream and commercial UV protection creams, at the lower amount of zinc oxide nanoparticles can absorbed UV as well as the higher amount of micronized zinc oxide particles. The physical properties of nano zinc oxide UV protection cream showed more quality such can transparent on the epidermis (the top layer of skin) and have the lower cost of UV protection cream than on the market because of the product used Zinc oxide nanoparticles which produced in domestic that high performance as import products. Therefore nano zinc oxide UV protection cream can reach at all levels of people and everyone can used nano zinc oxide UV protection cream on everyday because of the high performance and lower cost so easy decide to buy and used it.

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Appendices

Appendix A

Experimental Equipment

A-1 Direction of UV-VISIBLE Spectrophotometer (Shimadzu UV-160A)

UV-VISIBLE Spectrophotometer (Shimadzu UV-160A) is a double beam UV-Visible recording spectrophotometer with a 10 mm quartz cell was used for all spectrophotometric measurements.

1. Turn on switch machine UV-VISIBLE Spectrophotometer which side of the machine, then wait about 3 minutes of screen shows a basic mode menu and allowed to warm up for 15 minutes.
2. Select Mode if you want to scan spectrum of light absorption to select mode 2 by pressing no. 2, then press Enter. The screen will ask parameter change y / n?
3. Then if you want to set the wavelength to scan, press yes and then press 1 and Enter to set the wavelength to scan.
4. The screen will ask parameter change y / n?
5. When set parameters already then press Start. UV-VIS spectrophotometer will scan absorption follow the wavelength that we set.
6. Bring the data from this experiment reported in table.

Figure A.1 UV-VISIBLE Spectrophotometer (Shimadzu UV-160A)

A-2 Direction of Optometrics LLC SPF-290S

Optometrics LLC SPF-290S is spectrophotometer for determining Sunscreen Protection Factors (SPF). This method is called In vitro test. A procedure performed in vitro (Latin : within the glass) is performed not in a living organism but in a controlled environment, such as in a test tube or Petri dish. Many experiments in cellular biology are conducted outside of organisms or cells; because the test conditions may not correspond to the conditions inside of the organism, this may lead to results that do not correspond to the situation that arises in a living organism. The SPF-290S is a recording UV spectrophotometer designed and optimized for the determination of SPF values on a variety of UV protection creams and cosmetic products. The SPF-290S was designed specifically to measure the transmittance of material containing sunscreen products. Since these materials typically have low transmittance, the instrument was designed to detect very low levels of transmitted light. Optometrics LLC SPF-290S setting the standard for in vitro SPF assays of :

- Lotions
- Creams
- Cosmetics
- Fabrics

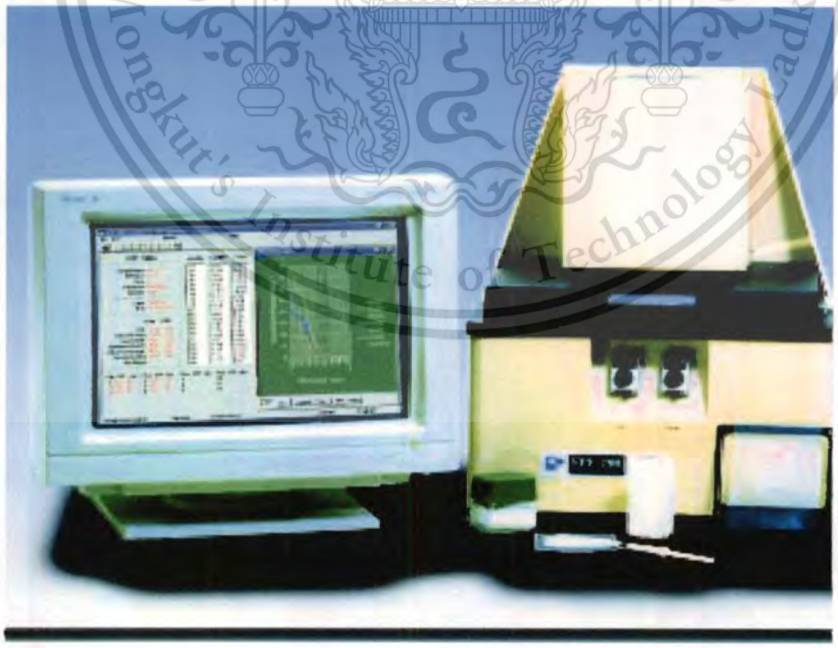

Figure A.2.1 Optometrics LLC SPF-290S

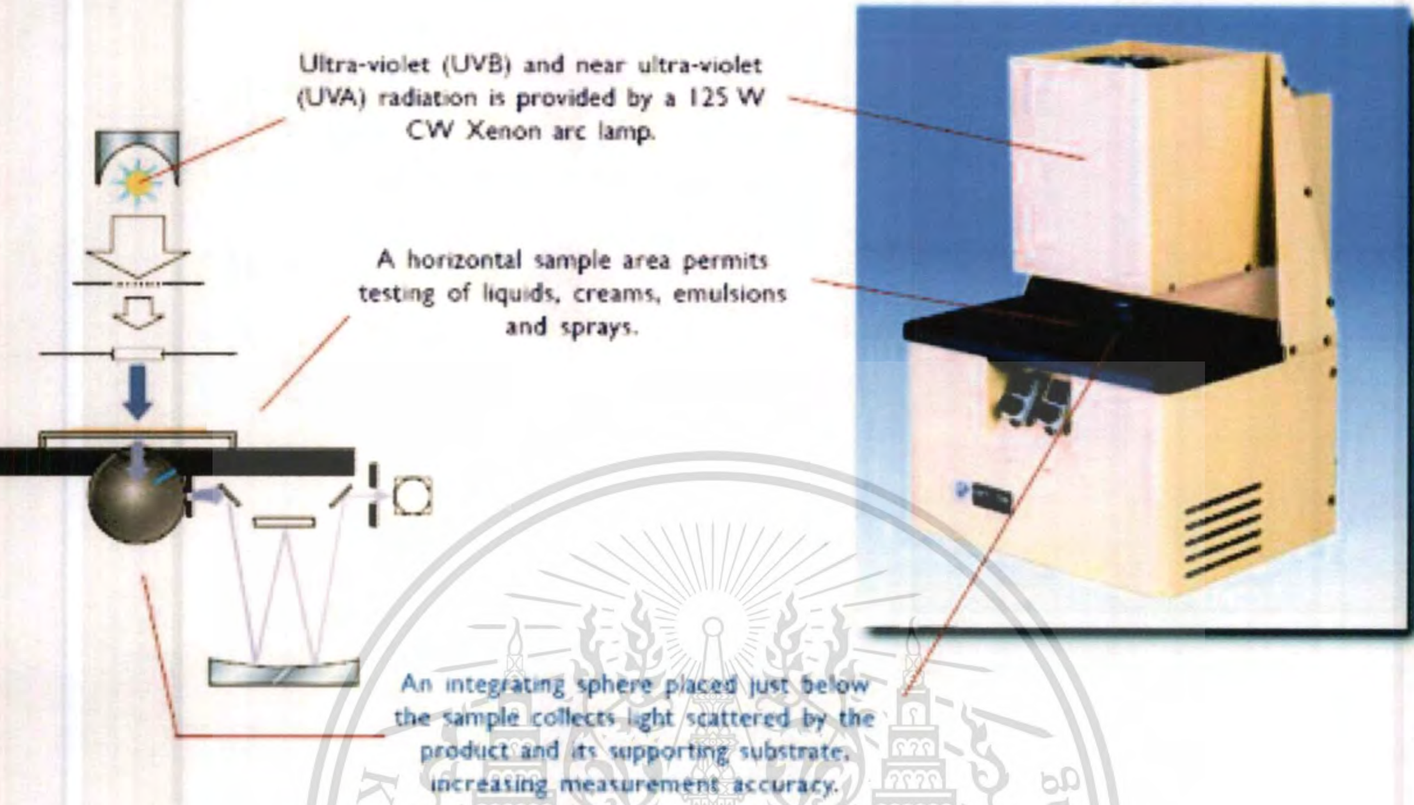

Figure A.2.2 The diagram of Optometrics LLC SPF-290S

Appendix B

B-1 Commercial UV protection cream

Example 1 : ORIENTAL PRINCESS (SPF 30)

Figure B.1.1 Natural sunscreen enriched protection & whitening (SPF 30)

Ingradients :

water, ethylhexyl, methoxycinnamate, ethylhexyl, salicylate, titanium dioxy/glycerin/isolaureth phosphate/vinyl buteth-25/sodium maleatecopolymer, propyleneglycol, polyglyceryl-10 pentastearate/ behenyl alcohol/sodium stearoyl lactylate, glyceryl stearate/peg-100 stearate,benzophenone-3, ammonium acryloyldimethyltaurate/vp copolymer, ethylhexyl stearate, butyl methoxydibenzoylmethane, C_{12-15} Alkyl benzoate, vp/hexadecane copolymer, alcohol/butylenes glycol /camella sinesis leaf extract, glycyrrhiza glabba(licorich) root extract, paeonia suffruticosa root extract,pueraria lobata root extract/aloe barbadensis leaf extract/chlorella vulgaris extract, sodium hydroxide, xanthan gum, imidazolidinyl urea, methylparaben, propylparaben, disodium edta, fragrance

Example 2 : NIVEA (SPF 30 PA++)

Figure B.1.2 Nivea sun moisturizing immediately sun protection and collagen protection (SPF 30 PA++)

ingradients :

aqua, ethylhexyl salicylate, homosalate, ethyl hexyl methoxycinnamate, alcohol denat, cetearyl alcohol, peg-40 castor oil, sodium cetearyl sulfate, distarch phosphate, butyl methoxydibenzoylmethane, sodium phenylbenzimidazole sulfonate, dimethicone, glyceryl stearate SE, cetyl alcohol, glycerin, ethylhexylglycerin , hydrogenated coco-glycerides, tocopheryl acetate, parfum, xanthan, gum, phenoxyethanol, methylparaben, trisodium EDTA, BHT, ethylparaben , propylparaben

Example 3 : BANANA BOAT (SPF30)

Figure B.1.3 SPORT UVA & UVB SUNSCREEN LOTION (SPF30)

Ingredients :

Aqua, Elthylhexyl Methoxycinnamate, Benzophenone-3, Ethylhexyl Salicylate, Stearic Acid, Stearyl Alcohol, Polyethylene, Methyl Actyl Ricinoleate, Glyceryl Stearate, PEG-40 Castor Oil, Titanium Dioxide, Isopropyl Myristate, C_{12-15} Alkyl benzoate, Magnesium Alluminum Silicate, Silica, Octadecene/MA Copolymer, Ceteareth-20, PEG-7 Glyceryl Cocoate, Alumina, Polyhydoxystearic Acid, Imidozolidinyl Urea, Quatenium-15, Triethanolamine, Tocopherol, DMDM Hydantoin, Hydroxyethylcellulose, Trisodium EDTA, Hydrolyzd Collagen, Aloe Barbadensis, Iodopropynyl Butylcarbamate. Contains Oxybenzone.

Example 4 : SUIHONG (SPF60)

Figure B.1.4 Suihong Magic White Body Sunblock (SPF60)

caution :

1.using cosmetic products with sunscreen is only one method of helping to reduce the dangerous risks of exposure to sunlight.

2. carefully read and strictly follow the instruction before use

3. should any abnormalities occur after application, immediately discontinue usage and consult a physician