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Faculty of Mathematics and Sciences of matter Chemistry Departement

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Unitled

Dune sand supported meniral oxide as photocatalyst for water treatment.

Publicly discussed before the Discussion Committee

on:...

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University Year: 2024/2025

Dedication

Thank God, with love and gratitude, by whose grace I am today preparing for a long-awaited dream that has now become a reality I am proud of.
The journey was not short, nor should it have been. The dream was not close, nor was the path easy, but I did it and I achieved it.
I dedicate this graduation, which I hope will be a source of pride,

to the hidden hand, the tender heart, and the owner of sincere prayers, my unwavering support, who has been and still is the first supporter and strong pillar – my dear mother. Were it not for your patience and generosity, I would not have reached where I am today. To the pure souls of my father and brother, who remain in my memory they left with their bodies, but their remembrance remains in my heart and mind. And to those whom God blessed me with their presence, my dear brothers and sisters, who shared aspects of my life's journey. And to my loyal friends who were the best help and companions to me, this achievement is an expression of my thanks and appreciation to all of you."

Rahima Ghounani

Dedication

In the name of God, I begin, and by His Book, I find guidance, and by the Sunnah of His Messenger, peace be upon him, I follow.

I dedicate this success.

To my father, whose name I carry with pride, and to my mother, who instilled in my heart the love of knowledge and determination. O God, protect them for me, and have mercy on them as they raised me when I was small.

To each member of my family, my sincerest love and gratitude to you all for your support and presence.

To my friends, I am grateful for your presence in my life. Thank you.

I dedicate this message primarily to the crowns of heads. I know that no matter how loud the pen's voice rises, it will not reach the sound of the rifle, and no matter how eloquent the ink is, it will seem weak in the presence of blood. But these are just words in my chest that I wanted to write, to every child, woman, elder, doctor, medic, and journalist who has been martyred in this war, to Yaqeen, Dr. Alaa Al-Najjar, to the spirit of the spirit (Abu Diyaa)To Dr. Hossam Abu Safiya, to Dr. Munir Al-Barash, to Noah, to Ismail Al-Ghoul, to Saleh Al-Jafrawi, to Wael Al-Dahdouh, to all our people in Gaza, every joy in your affliction is a pang, may God accept your martyrs, heal your sick, free your captives, strengthen your hearts, bring down tranquility upon you, grant you victory over your enemies and those who have forsaken you, for He is capable of all things.

To our martyrs' leaders, God willing, we consider them martyrs in the gardens of eternity, O Lord. They were martyred, but they remain alive in our hearts. To our proud resistance, O God, guide their aim and their vision, and grant victory to the fighters in Your cause.

And finally, O Allah, we entrust you with Al-Aqsa Mosque, the first of the two Qiblas and the third of the two Holy Mosques. O Allah, purify it from defilement.
Indeed, there is no jihad, victory, or martyrdom. Peace be upon you.

Takoua Benmeriem

Acknowldgment

"My Lord, enable me to be grateful for Your favor which You have bestowed upon me and upon my parents and to do righteousness of which You approve and admit me by Your mercy into Your righteous servants."

To the teacher of humanity who delivered the message of his Lord, preserved the trust, and offered advice to his nation, to the one who was a mercy and a light to the worlds:

"Our Prophet Muhammad, may the best prayers and peace be upon him."

We thank Allah Almighty who granted us success in completing this research. We can only express our deep gratitude and great appreciation to Professor Dr. Allaoui Abdelfattah, who graciously supervised our thesis. His great patience and valuable scientific guidance played a fundamental role in the completion of this work, and words cannot do him justice. We also thank Professor Ouezani Meroua for her efforts with us. We extend our sincere thanks to the Public Works Laboratory of Ouargla. And we offer our special thanks to all the esteemed professors for accepting to discuss this thesis, especially the head of the discussion committee, Professor Ben menin Abd alkader, and Dr.Ben ali Mosstapha as an examining member.

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List of Abbreviations

Symbol	Significance
MeO	Methyl Orange
BV	Parity package
BC	Delivery package
OH •	Hydroxyl radical
e^{-}_{BC}	Electron
h^{+}_{BV}	Positive hole
Nm	Nanometers
λ	Wavelength (nm)
UV	ultraviolet light
$O_2^{\bullet -}$	superoxide
FTIR	infrared spectroscopy
SEM	Scanning Electron Microscopy
UV-Vis	ultraviolet and visible

General introduction

General introduction

Most human activities are linked to natural water sources. Although water is considered a renewable resource, the numerous pollution factors around us have led to the contamination of water sources such as seas, rivers, wells, and groundwater, making them unsuitable for human, animal, or plant use. This pollution also leads to a gradual decrease in water availability worldwide[1]. Currently, pollution represents one of the most significant problems faced by researchers. In recent years, the serious environmental issue has threatened human survival and development. Among the various environmental pollutants, water pollution has become more severe with rapid industrial development and population growth. Therefore, there is an urgent need for an environmentally friendly and energy-saving method to treat water in the field of chemistry. [2]

Dyes pose a significant environmental risk due to their stable chemical composition and toxicity. Their production and use release harmful substances into the environment, contaminating water and soil, which threatens living organisms. Among these dyes is Orange II, which is one of the common industrial dyes belonging to the azo dye group. Its chemical properties make it a dangerous pollutant when improperly disposed of, especially in water, posing a threat to the environment and living organisms. It is used as a dye for certain fabrics and sometimes in paper, food industry, plastic industry, construction paints, textile industry, cosmetics and decoration, construction, and printing. Methyl orange is considered a compound that does not easily biodegrade, leading to its accumulation in water and soil when discharged untreated. Its strong color can also hinder light penetration in water, affecting the photosynthesis process of aquatic plants. Additionally, it exhibits toxic effects on aquatic organisms such as fish and microorganisms at high concentrations. Methyl orange is not effectively removed in conventional wastewater treatment plants. Therefore, treatment studies have relied on advanced techniques and appropriate methods to eliminate this type of dye, which has become a real problem, especially at certain levels and concentrations. One of the most important techniques used to address this issue is advanced oxidation processes because they allow for the complete degradation of the pollutant while reducing its toxicity in the liquid medium, unlike other processes. The photocatalytic decomposition technique has shown high effectiveness in removing many obstacles across various fields.

Semiconductor-catalyzed photodisassembly technology has recently become the focus of attention because it aims to destroy contaminants in water in non-toxic, low-operating temperature processes.As a cheap and environmentally friendly technology, it has received widespread attention.Photocatalyst plays a key role in high-efficiency photocatalysis.[3]In our study, we relied on natural resources, Dune sand and sunlight

Dune Sand represents a valuable natural resource that can play a pivotal role as a support in photocatalytic applications, particularly in water treatment. Its abundance, low cost, and possibility of modification are all factors that make it a promising option that deserves further research and development.These low-cost processes can also use sunlight as a source of radiation.It is considered one of the best resources among other renewable sources as it contains 52% of infrared radiation and 43% of visible light and 5% of ultraviolet radiation. [4]

We have divided this memorandum into two parts: a theoretical part and a practical part

The theoretical part included one chapter

Chapter One: We conducted documentary research through which we provided information about the distribution of sand worldwide and in Algeria, the origin and how sand dunes are formed, the definition of sand and sand dunes, the types and characteristics of sand dunes, the definition and uses of quartz, the uses of sand dunes, photocatalysis, Persistent organic pollutants, inorganic pollutants, information about dyes and colorings, their uses and treatment methods, definition of orange methyl, its danger and toxicity, and its uses, previous studies

The practical part includes two chapters:

Chapter Two: relates to the materials, devices, and techniques used during the work stages.

Chapter three: In it we have analyzed, discussed and interpreted the practical results obtained.

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Chapter one

Generalities and previous studies

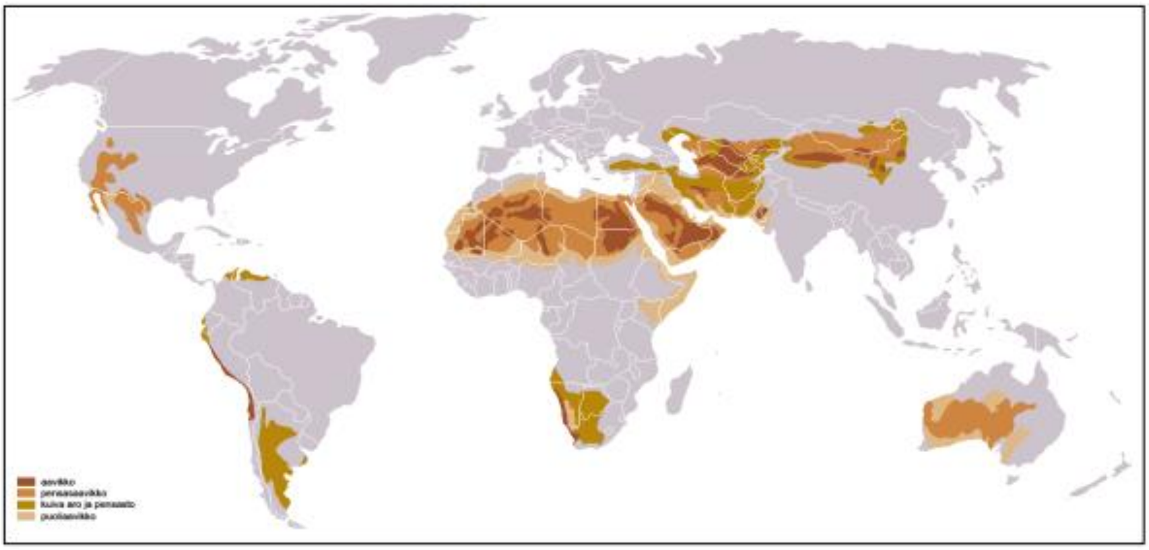
I.Introduction :

Dune Sand is one of the prominent geographical features of Algeria, covering vast areas, especially in the south, which includes a large part of the Sahara Desert. Sand consists of small, loose grains formed by the erosion of rocks, minerals, and dry organic materials due to various natural factors such as wind, rain, and waves, as well as freeze-thaw cycles in cold regions. Given the long period required for sand formation, this natural resource is considered renewable.

I.1. Distribution of sand in the world :

Dune Sand covers nearly five million square kilometers of the Earth's surface, mostly in desert areas and along beaches [1]

Dunes are found in almost all climates with more than 99% found in deserts and less than 11% located in humid climates and along coasts, where sand dunes cover up to a quarter of many desert areas and sandy desert areas and the area of the largest deserts in the world, for example the Sahara Desert (Africa) 9. 100,0000 km², the Gobi Desert (Asia) 1,300,000 km², 100,0000 km², Gobi Desert (Asia) 1,300,000 km², Great Victoria Desert (Australia) 670,000 km², Kalahari Desert (Africa) 370,000 km², Great Basin Desert (North America) 490,000 km², Syrian Desert (Middle East) 490,000 km² .[2] [3] [4] Figure(I-1)



Figure(I-1): The distribution of sand dunes in the world [5]

I.2. Distribution of sand across Algeria :

Sand dunes cover about 18% of the African Sahara [6], of which Algeria is the largest country. The area of Algeria is estimated at 2.4 million square kilometers, and the desert occupies more than four-fifths of its total area. Sand dunes alone make up nearly a third of the desert, equivalent to a quarter of the total area of Algeria [7], the Algerian desert has a huge stock of dune sand that covers more than 40% of its area, which is a natural, local and free source of quartz, which represents more than 70% of the sand composition in the Algerian desert [8]. Algeria contains huge and long chains of sand dunes, called veins. These veins are distributed over the desert from east to west. Figure(I-2)

Figure(I-2): The distribution of sand dunes in Algeria [5]

I.3.The origin and formation of sand dunes :

Sand dunes are a natural phenomenon common in most arid and semi-arid regions, as a result of the accumulation of sand thrown by the carrier winds after their speed decreases, which takes many shapes and sizes, depending on several factors, including wind speed [9] The origin of sand dunes is represented in erosion factors, as the wind is the first factor responsible for the process of removing the sediments that disintegrated as a result of weathering processes and moving them to other

places on the surface of the earth, and the interaction of rocks with extreme temperatures which leads to the dismantling of rocks and breaking them into sand grains. [10] [11]

I.4.1.Definition of sand dunes :

sand dunes are mainly composed of 65-60% sio2 quartz grains and contain small amounts of impurities and heavy metals, a significant percentage of Fe_2O_3,

$CaCO_3$, and a larger percentage of Al2o3, and are chemically composed of the same chemical components of the rocks from which they originated. [12]

I.4.2 .Definition of Sand :

Sand is the granular particles of loose, loose rock. The composition and color of sand changes according to its origin as the sizes of sand grains range between[14]

0.625mm and.2mm despite the difference in qualities and quantities, sand is mobile in terms of size, meaning

that the sand grains are light so that they move in the air, pregnant, heavy and suspended, otherwise they are called pebbles, but they fall quickly so that they do not remain suspended in the air, otherwise they are called dust. Here we can say that the size of sand is larger than the size of dust and less than the size of pebbles.[15]

I.5.Types of sand dunes :

Wind is one of the most influential geographical factors in the formation of sand dunes. Therefore, wind is the first factor responsible for the process of removing sediments that have been disintegrated as a result of weathering processes and transporting them to other places on the earth's surface [16]

∗ Simple sand dunes :

It consists of individual dune forms that are spatially separated from the strong dunes .[17]

∗Complex sand dunes :

It is the fusion of two or more different types of simple sand dunes . .[17]

I.6.Sand dune shapes :

Sand dunes are categorized in different ways by their size, shape, and the direction of the winds that form them:

I.6.1. crescent sand dunes :

These dunes are formed in areas with a constant wind direction and are formed in groups and rarely singly, with a height between (20_30) meters, up to 150 meters long and crescent-shaped Figure(I-3).[18]

Figure(I-3): Crescent sand dunes[18]

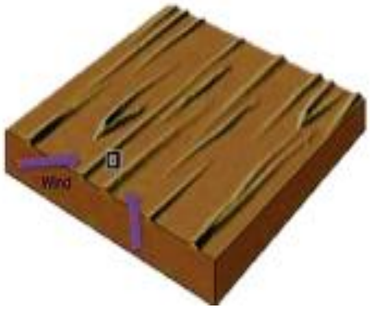
I.6.2 .Transvers sand dunes :

They appear in areas where the wind direction is perpendicular to the original direction, so named because they intercept the prevailing wind Figure(I-4).[18]

Figure(I-4):transvers sand dunes[18]

I.6.3. Longitudinal sand dunes :

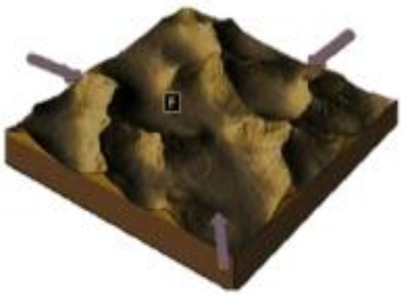
They form in windy areas with little sand and may reach a height of about 100 meters and a length of 400 meters Figure(I-5) .[18]



Figure(I-5): Longitudinal sand dunes [18]

I.6.4. Star sand dunes :

They are characterized by their large sizes and pyramidal shape, reaching a height of more than 300 meters. Figure(I-6) [18]



Figure(I-6): Star sand dunes[18]

I.7. Some mineral components of dune sand :

X-ray fluorescence (XRF) technology enables us to determine the chemical composition and weight percentages of various elements constituting dune sand [19]. Table (I-1)presents the results of the chemical analysis

Table (I-1): Chemical analysis results[19]

Oxide	SiO_3	Al_2O_3	Fe_2O_3	MgO	$CaCo_3$	Other materials
Weight ratio	86.04	6.63	1.35	0.08	0.86	About 5.00

I .1.7. Quartz is a primary component of dune sand :

Sand consists of various types of minerals, primarily silicon-based. The main minerals are classified as follows: quartz, the most abundant family in nature, comprising over 90% of the Earth's crust's weight, carbonates, and clay. The latter is usually present in trace amounts in sand. [20]

∗Definition of Quartz :

Quartz is silicon dioxide SiO_2 (silicon dioxide) It has a melting point in the range of 1700℃ However, its purity can be diminished by the presence of other substances. The inclusion of organic material within quartz is possible and affects its properties. Quartz has a vitreous to greasy luster, but the presence of oxides like iron, titanium, and manganese can impart a specific color to it.

Quartz occurs in nature as thin, microscopic flakes or fibers, exhibiting hexagonal and rhombohedral forms. It commonly exists in consolidated or fragile states [21]. Figure (I-7)

Figure (I-7): Image of rock crystal quartz [22]

∗Physical Properties of Quartz :

Quartz is one of the crystalline forms of silica, found in nature in more than one mineral form depending on the crystallization conditions of pressure and temperature. Quartz crystallizes [22, 23] according to the trigonal system at temperatures below 573°C, and in this state, it is a stable phase, called the α phase, with a specific gravity of 2.65 g/cm^3 as it also crystallizes in the hexagonal crystal system 573-870 ℃ and it is called Al-Turβ and it is Specific weight 2.53 g/cm^3

Table (I-2): Key Properties of Quartz[8]

Property	Unit	Value
Volumetric mass	g/cm^3	2.65
Refractive Index	-	1.543
Melting Point	℃	1710
Elastic Modulus	GPa	54
Compressive Strength	MPa	1200

∗The crystal structure of quartz :

The quartz is a structure made up of tetrahedra SiO_4, which are connected to each other by sharing a vertex with another tetrahedron [23], as shown in the figure (I-8)

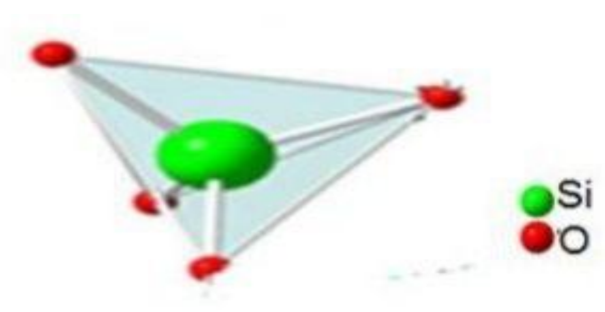


Figure (I-8): The crystalline structure of SiO_4

The formed compound has three dimensions, with each silicon atom (silicon) bonded to four oxygen atoms (oxygen) and each oxygen atom bonded to two silicon atoms. The structural unit of the crystalline cell consists of three groups, each within one unit cell, with three silicon atoms from the adjacent cell. This arrangement forms an irregular hexagonal shape. Figure (I-9)

The primary dimensions of the crystal structure cell of triclinic quartz are [24]:

$$\mathbf{a} = \mathbf{b} = 4.9294\ \text{Å} ; \quad \mathbf{c} = 5.4093\ \text{Å}; \quad \mathbf{V} = 113.832\ \text{Å}^3$$

$$\boldsymbol{\alpha} = \boldsymbol{\beta} = 90° ; \quad \boldsymbol{\gamma} = 120°$$

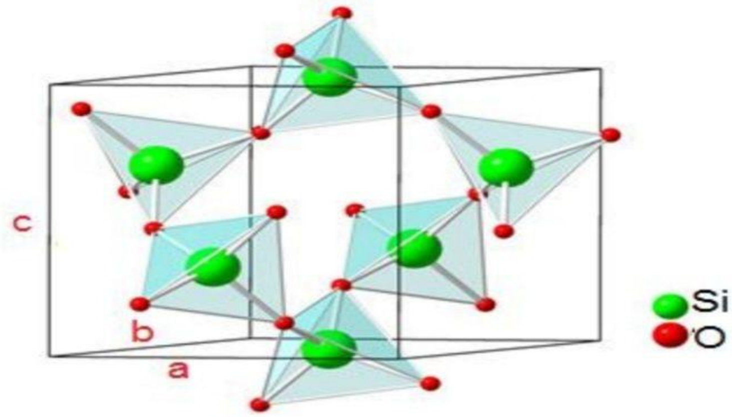


Figure (I-9): The crystal structure of quartz[25]

The bonds in quartz do not have the same length. Each silicon atom is surrounded by four oxygen atoms, two of which are at a distance of 1.603Å and the other two are at a distance of 1.163Å

- **Uses of quartz :**

Colored varieties of quartz have been used in jewelry making since ancient times, but most quartz is used as an ingredient in concrete components such as quartz sand and quartz gravel. The production of glass, ceramics, and chemical devices requires pure quartz, as molten silica is produced by rapidly cooling molten quartz.
Quartz has several interesting properties, including a very low thermal expansion coefficient, transparency to ultraviolet light, and being [21]

chemically inert. It can also be formed into thin but strong fibers used in physical instruments.

Quartz is also used as a resonator in electrical circuits in clocks and computers, and as a membrane in devices that operate with ultrasound.

I.7.2. Gypsum or Plaster :

Gypsum is one of the most important sulfurous minerals widely distributed in nature. It is calcium sulfate dihydrate ($CaSO_42H_2O$), and it is found in sedimentary rocks, where it forms as a result of the precipitation of calcium sulfate from seawater. It is usually associated with other deposits such as halite (rock salt, NaCl) and anhydrite ($CaSO_4$), in addition to limestone [26]. It can also be found sometimes in the Earth's crust at depths of up to 350 meters. [27] Gypsum is also formed in volcanic [26] regions through the reaction of sulfuric acid with calcium-containing minerals. It is present in most types of clay as a result of the reaction of sulfuric acid with limestone. Gypsum crystallizes according to a (monoclinic [27]) crystal system. Figure (I-10)

(a **(**b

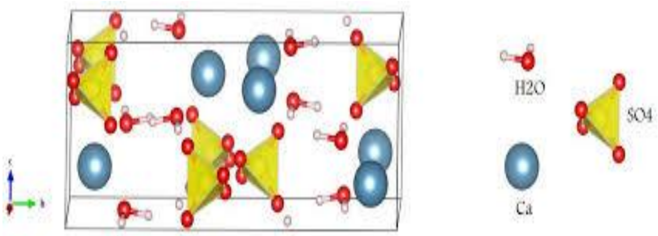


Figure (I-10): a**)** Image for gypsum stone [26] . b**)** The crystal structure of gypsum[28] .

Gypsum is characterized by its white[31], almost transparent color, and it can appear in black, yellow, or green due to impurities.

Gypsum has a low hardness[26], as it can be scratched with a fingernail. When heated to temperatures exceeding 128°C, it gradually loses its water content, and it may decompose at high temperatures.

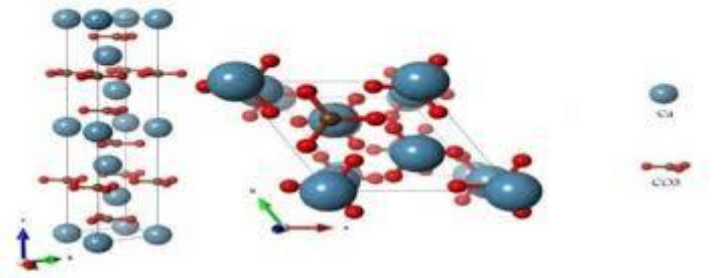
I.7.3. Limestone or Calcite :

It is a sedimentary rock primarily composed of calcium carbonate ($CaCO_3$), usually in the form of calcite or aragonite. It may contain significant amounts of magnesium carbonate (dolomite), and in some cases, it contains other components in small quantities, such as clay, iron carbonate, feldspar, pyrite, and quartz [26].

Most limestones have a granular texture ranging from 0.001 to large visible grains. They are often white in color, but impurities such as silt, sand, and iron oxide can cause them to be colored in various shades. Figure(I-11)

(a

(b



Figure(I-11): a) Image for crystal stone[26]. b) The crystal structure of limestone [29].

Lime (CaO) has important uses in glassmaking and agriculture, while limestone rocks are primarily used in construction [26.27]. Some of its geological layers serve as reservoirs for oil or natural gas[27.32].

Table(I-3): shows some of the physico-chemical properties of the main components of sand[34.33.32]

Physicochemical Properties				
		Quartz	**Gypsum**	**Calcite**
Chemical formula		SiO_4	$CaSO_4\,2H_2O$	$CaCO_3$
Molar mass (g/mol)		100.089	172.173	60.085
Molar volume(Cm^3)		22.688	74.440	2.7106
Solubility		Insoluble	In HCl acid with heating	In diluted acids
Hardness (hos)		7	2-1.5	3
Density(g/Cm^3)		2.7106	2.7106	2.7106
Crystallization		Trigonal hexagonal	monoclinic	Trigonal
Crystal cell dimensions	**a (Å)**	4.9134	5.670	4.9896
	b (Å)	_	15.201	_
	c (Å)	5.4052	6.533	17.0610
	β(°)	_	118.60	_
Space group		$P3_121$ or $P3_221$	I2/a	R3c
Color		Transparent, pink, black	White, transparent, black, yellow, green...	White
Luster		Glassy-waxy	Glassy to silky, pearly, or waxy	Glassy to pearly on the cleavage surface
Transparency		Transparent to nearly opaque	Transparent to translucent	Transparent to translucent
Refractive index		1.543-1.554	1.519-1.530	1.486-1.660
Electrical resistance (Ωm)		$10^{16}\times2$_$10^{12}\times4$	1.21×10^{14}	2×10^{12}
Melting point(°C)		1705-1713	_	_

I.8. Properties of Dune Sand :

I.8.1. Physical properties of sand :

∗Classification of sand grains :

In geological classifications, sand is considered only the particles with diameters ranging from 0.063mm to 2mm. Those with diameters between 20mm and 64mm are called gravel, and particles with diameters ranging from 0.002mm to 0.063mm are called silt. Sand is divided into four groups according to its types [38], as shown in the table (I-4)

Table (I-4): Classification according to particle diameters : [35]

classification	Dimensional
(gravel)	2 mm < gravel
(sand)	0.063 mm < sand < 2.0 mm
(silt)	0.002 mm < silt < 0.063 mm
(clay)	clay < 0.002 mm

∗Grain gradation of sand :

Sand is classified based on gradation into the following types:

- Well-graded sand: This is sand that contains the appropriate proportions of different sizes.
- Graded sand: This is sand that contains most sizes regardless of their proportions.
- Poorly graded sand: This is aggregate that lacks one or more specific sizes of different grains. [39]

∗Shapes of sand grains :

The appearance of the sand surface is due to various factors that the sand grains are exposed to during movement, such as wind and water. Sand grains are classified according to their shape, based on the angle and roundness. The grains of sand vary from well-rounded to rounded, sub-rounded, or angular. This classification is determined by the degree of sphericity and roundness. Sphericity refers to the degree of how close the grain is to a spherical shape

based on the ratio of its three main axes. There are spherical, discoidal, foliaceous, platy, and elongate grains. Roundness, on the other hand, refers to the degree of smoothing of the corners of the grain. According to the internationally recognized roundness scale, grains are divided into very angular, angular, sub-angular, sub-rounded, rounded, and very rounded categories. [36]. Figure (I-12):

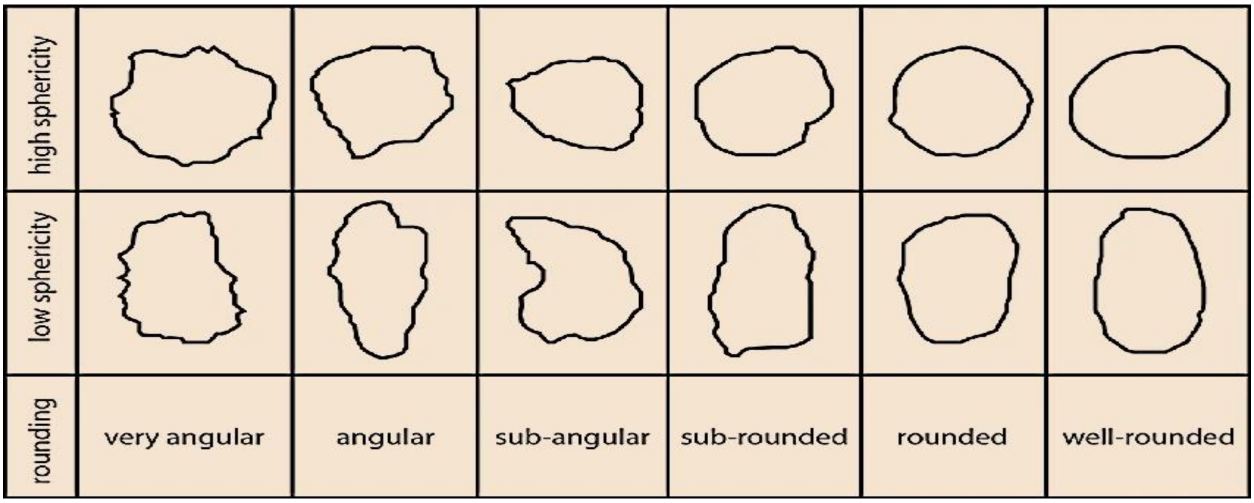


Figure (I-12) : Sphericity and roundness of Grain [40]

∗Colors of sand grains :

Sands and sandstones have different colors depending on the materials they contain. These colors can be light, white, transparent, or opaque, and may also be brown or red. Commonly, they are rusty when containing iron, and occasionally, they may be black due to the presence

of the mineral magnetite (Fe2O3) or organic materials. [41]

In a previous study, we examined the surfaces of colored sand grains

using Energy Dispersive X-ray Spectroscopy (EDS) and found that brown sand grains contain relatively large amounts of silicon (Si) and significant amounts of iron (Fe). Transparent white sand grains mainly contain large amounts of calcium (Ca) and sulfur (S). If they are opaque, it indicates the presence of a small concentration of potassium (K). Gray and black grains contain significant amounts of silicon (Si) and oxygen (O), as well as considerable amounts of potassium. Figure (I-13)

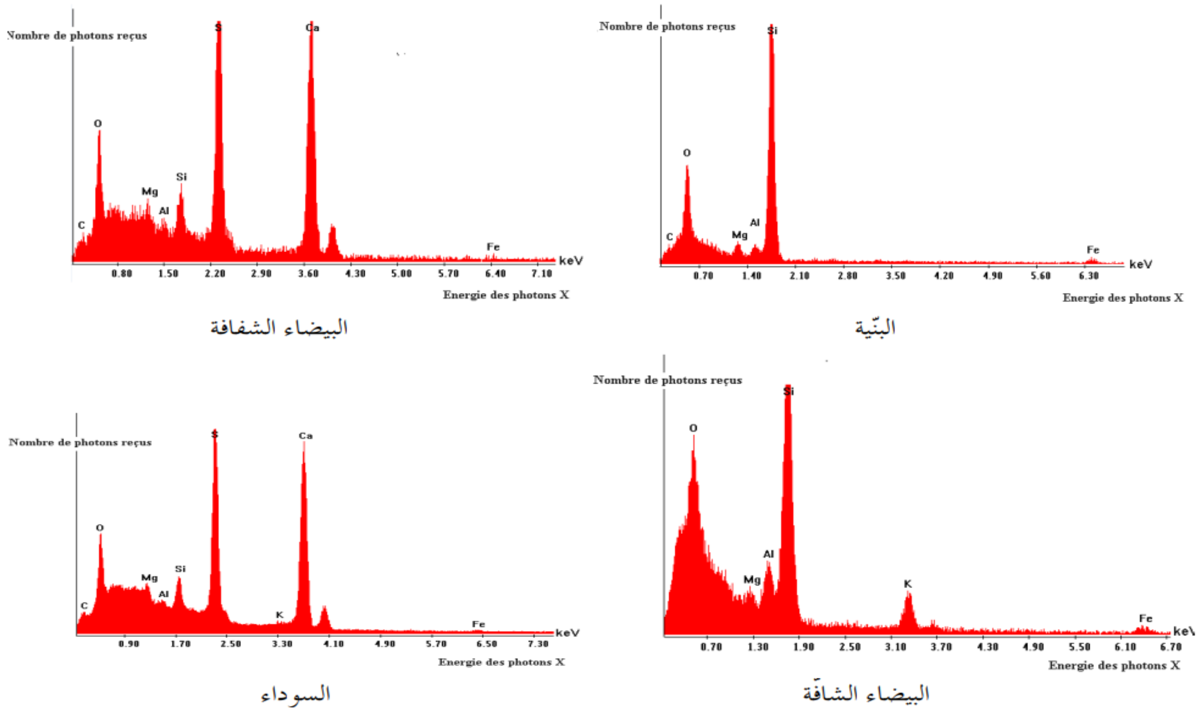


Figure (I-13): Surface Analysis of Sand Samples of Different Colors Using EDX Technique[41]

I.9. Uses of Dune Sand and Its Economic Importance :

Dune sands are classified as valuable raw materials used in many industries. They are the primary material used in the production of glass and electronics. Additionally, they are used in various proportions in the production of cement, ceramics, and construction materials. Dune sands are also used in polishing, sharpening, and water purification processes. Moreover, asphaltic quartz sands are used in road paving.

The high porosity and permeability of quartz sands and sandstones give them good storage properties, making them important oil reservoirs that allow the accumulation of hydrocarbons. This makes them capable of containing vast reserves of crude oil and natural gas. If we exclude the massive carbonate fields around the world, sands and sandstones hold two-thirds of the world's reserves of oil and natural gas.

The importance of quartz sands is not limited to this, as hydrocarbon fields are easier to detect in sand deposits compared to carbonate fields. Furthermore, quartz sands are not affected by the physical and chemical changes that lead to the loss of porosity, as seen in carbonate rocks. [2]

II.1.Photocatalysis :

Photocatalysis is a reaction that uses light to activate a substance that produces strong oxidants. When light photons are absorbed, molecules transition from their ground state to an excited state. This substance is called a photocatalyst, and it continues to oxidize, breaking down the bonds in toxic organic materials and converting them into substances with lower molecular weights until they are eventually transformed into carbon dioxide and water. This complete process is called mineralization.

Often, this photocatalyst is in the form of a semiconductor that possesses an energy band gap between the valence band and the conduction band. The photocatalysis process can be summarized as follows:

- Photocatalyst excitation
- Transfer of pollutant molecules to the surface of the photocatalyst
- Photocatalytic degradation reactions

There are two types of photocatalysis: homogeneous photocatalysis and heterogeneous photocatalysis. [42.43]

II.1.2.Homogeneous Photocatalysis :

Photocatalytic technologies are easy to use, clean, and inexpensive. Furthermore, they possess the unique ability to purify and treat pollutants. Consequently, they have become increasingly utilized in recent years and are likely to replace traditional methods such as adsorption on activated carbon and biodegradation. [42.43]

II.1.3.Heterogeneous Photocatalysis :

In this technique, the photocatalyst used is a semiconductor that is insoluble in water, such as titanium dioxide (TiO_2). When a light beam with a wavelength shorter than 380 nm (i.e., with energy greater than the band gap of the catalyst in this case, greater than 3.2 eV) is shone on the TiO_2 catalyst, electrons are transferred from the valence band (VB) to the conduction band (CB), forming an electron-hole pair on the surface. Thus, there are electrons (e^-) in the conduction band and positive holes (h+) in the valence band[42.43]

TiO_2 + hv (UV) →TiO_2 (e^-_{BC} , h^+_{BV})…………….(1)

- **At the Valence Band BV :**

Oxidation reactions occur as a result of electron transfer from RX (organic pollutant), water molecules H_2O, and hydroxyl ions OH^- adsorbed on the catalyst surface. [42.43]

$TiO_2(h^+) + RX_{ads} \rightarrow TiO_2 + RX^{\bullet +}_{ads} \rightarrow$ oxidation of RX ……..(2)

$TiO_2(h^+) + H_2O_{ads} \rightarrow TiO_2 + H^+ + OH^{\bullet}_{ads}$……………………..(3)

$TiO_2(h^+) + OH^-_{ads} \rightarrow TiO_2 + OH^{\bullet}_{ads}$…………………..(4)

- **At the Conduction Band BC :**

Molecular oxygen participates in electron transfer reactions from the catalyst's conduction band to molecular oxygen according to the reaction: [42.43] Figure (II-14)

$O_2 + TiO_2(e^-) \rightarrow TiO_2 + O_2^{\bullet -}$ ……………………..(5)

$R + O_2^{\bullet -} \rightarrow ROO^{\bullet} \rightarrow \rightarrow \rightarrow CO_2 + H_2O$ …………………(6)

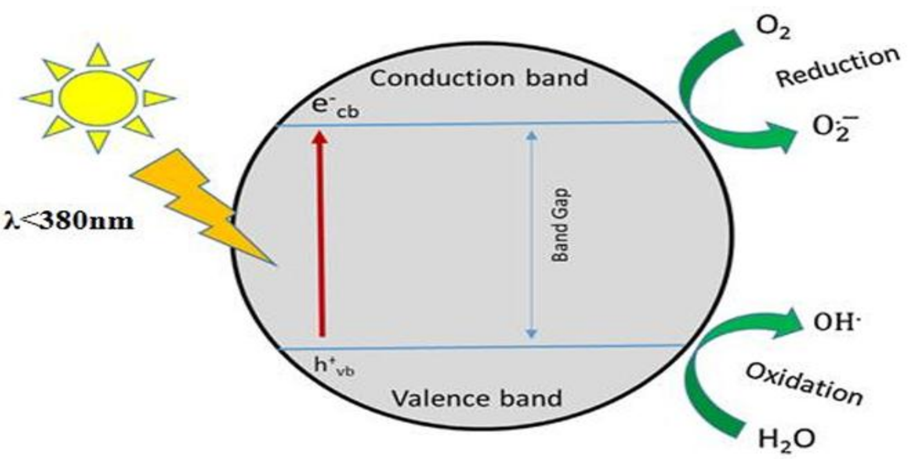


Figure (II-14): Photocatalytic Mechanism in the Presence of TiO2[44]

The presence of O_2 is a crucial factor in the occurrence of photocatalytic oxidation reactions, as it acts as an electron acceptor for the photogenerated electrons present in the conduction band, forming superoxide radical ions ($O_2^{\bullet -}$) These ions then react with the molecules adsorbed on the surface of the catalyst, forming free radicals according to the reactions:

$e^-_{(CB)} + O_2 \rightarrow O_2^{\bullet -}$…………………….(7)

$RH + O_2^{\bullet -} \rightarrow R^{\bullet} + OH^{\bullet}$ ……………………...(8)

II.2.Water pollution :

II.2.1. Chapter prelude:

Pollution is defined as a collection of harmful wastes and pollutants that have emerged as a result of human activity. There are several types of pollution, including air pollution, soil pollution, and water pollution, which has become a significant concern and danger to humans. Water pollution is defined as any physical, biological, or chemical change in water quality that negatively affects living organisms or renders the water unsuitable for its intended uses. It can also be defined as the damage or degradation of water quality, leading to an imbalance in the ecosystem, where pollution reduces the water's ability to perform its natural role and makes it harmful when used, diminishing much of its economic value . The causes of water pollution are numerous, including waste from agricultural activity, urban activity, and industrial activity by humans. Some of the wastes and pollutants resulting from these activities are transferred into various aquatic environments, including

- **Persistent organic pollutants :**

Persistent organic pollutants are toxic chemical compounds that pollute the environment worldwide. They accumulate in the tissues of humans and animals, causing serious diseases. They are known as a group of highly hazardous chemical pollutants that threaten human health and the ecosystem. These pollutants include chemicals used in industry and some substances produced during the combustion of certain industrial chemicals. Persistent organic pollutants can be classified into phenols, dyes, pesticides, etc.

Persistent organic pollutants are generally responsible for slight changes in the color and odor of water and also act as a substrate for bacterial growth, leading to biologically unstable water[45.46]

- **Inorganic Pollutants :**

Inorganic pollutants are often found in the environment in the form of heavy metals such as mercury, lead, copper, arsenic, nickel, cobalt, and manganese. The most toxic of these pollutants are lead and mercury.

The presence of these pollutants in the soil and their contact with water causes environmental pollution. [45.46]

II.3. General information about colorants and dyes :

Colorants are considered one of the most important pollutants in aquatic systems , where the quantity of dyes produced in 1996 reached (4.5) million tons, and most of these quantities are used in the textile industries and in fabric dyeing. Most dyes are either inert or non-toxic , but some of them have significant toxic effects on human health and the aquatic environment., Among these dyes or colorants is Methyl Orange, which possesses physical, chemical, and spectral properties. [47.48.49]

II.3.1.Treatment methods for dyes :

Large quantities of dyes are released, causing significant harm to the environment. To limit and remove these dyes, many countries are conducting extensive studies aimed at treating them, and several treatment methods have been discovered, including:

Chemical methods : Oxidation by ozone and oxygen, ion exchange

Biological methods : Aerobic and anaerobic treatments

Physicochemical methods : Membrane separation , Adsorption [50]

II.3.2.Uses of Dyes :

- Food industry
- Plastic and construction paint industry
- Textile industry
- Cosmetics industry
- Textile dyes for clothing, decoration, and construction
- Printing
- Pharmaceutical industry [51]

II.3.3.Definition of Methyl Orange Dye :

It is a toxic organic compound used in titration processes and appears as an orange powder with the chemical formula ($C_{14}H_{14}N_3NaO_3S$). It is soluble in water and insoluble in alcohol, exhibits weak amphoteric properties, and takes on a pink color at pH values less than or equal to 3.1 (acidic form is ionized), and a yellow color at pH values greater than or equal to 4.4 (alkaline form is unionized). It appears orange in the pH range between (3.1-4.4). [52]

II.3.4.Hazards and Toxicity of Methyl Orange Dye :

It belongs to the highly toxic azo compounds and can be fatal if inhaled in large quantities. When heated, it may decompose and produce toxic fumes. It is also considered a carcinogenic substance, and accidental ingestion of toxic doses can cause direct irritation through skin contact or inhalation[52]

II.3.5.Uses of Methyl Orange Dye :

- It is used in the textile industry and also in the paper and printing industries.
- It is widely used in the pharmaceutical and food industries.
- It is used in scientific laboratories. [52]

II.4.Previous studies :

Table (II-5): Summary of some previous studies

Research	Highlight results
Photocatalytic degradation of methyl orange as a model compound	Titanium dioxide (TiO_2) and sunlight were used to detoxify water polluted with methyl orange. No degradation of the pollutant occurred in the dark or without (TiO_2) under sunlight. It was found that the optimal amount of (TiO_2)was 0.4%, and the best concentration of the pollutant was 4×10^{-5} M to achieve the highest degradation rate. Additionally, a low pH (pH=3) yielded the best results in the degradation process[53]
Zinc Oxide Nanomaterials for Photocatalytic Degradation of Methyl Orange	Photocatalysis is attracting increasing interest for its applications in renewable energy and

	environmental remediation. Metal oxide semiconductors, such as zinc oxide nanoparticles, are promising materials as photocatalysts. This review presents recent advancements in the use of zinc oxide nanoparticles for the degradation of methyl orange, focusing on the impact of different nanostructures and reaction conditions like particle size, concentration, and pH on the efficiency of the process. [54]
Decomposition of methyl orange using C_{60} fullerene adsorbed on silica gel as a photocatalyst *via* visible-light induced electron transfer	This research paper investigates the degradation of methyl orange dye in water using C60 fullerene molecules adsorbed on silica gel (C60/SiO_2) as a photocatalyst when exposed to visible light or sunlight. The results showed that this system is effective in degrading the dye in the presence of ascorbic acid, with the degradation rate reaching 96% within 25 minutes. The main degradation products were identified. This system was also successfully applied in a continuous flow reactor to achieve continuous dye degradation[55]
Highly efficient photocatalysis powered by natural sunlight for the simultaneous degradation of rhodamine B and methyl orange using a TiO_2 photocatalyst	The study aims to develop an efficient photocatalyst for the degradation of dyes, especially using sunlight. A titanium dioxide material doped with carbon and iodine (I/C-TiO_2) was synthesized, which demonstrated a broad light absorption capacity and an improvement in photogenerated charge separation. This catalyst showed high

	efficiency in degrading two types of dyes under visible light and even natural sunlight, attributed to the enhanced formation of active free radicals[56]
Solar photoreduction of methyl orange using zeolite-supported photocatalytic materials	The study developed a new class of photocatalysts based on titanium dioxide supported on a zeolitic matrix and doped with transition metals and a heteropolyacid to enhance their activity. These catalysts demonstrated high efficiency in the photoreduction of methyl orange under sunlight, with one of them (containing cobalt) showing higher efficiency than commercial TiO_2 P25 under the same conditions. This high performance is attributed to the synergistic effect between the different components of the catalyst. These materials are currently being evaluated for their application in photocatalytic water splitting.[57]
Photocatalytic activity of poly(3-hexylthiophene)/titanium dioxide composites for degrading methyl orange	In this work, hybrid P3HT/TiO_2 composites were developed and demonstrated their effectiveness as photocatalysts in the degradation of the water pollutant methyl orange (MeO) dye. The integration of the P3HT polymer with TiO_2 nanoparticles enhanced the resulting material's light absorption capacity, allowing it to function efficiently under both ultraviolet and visible light. The photodegradation mechanism of MeO was observed to vary depending on the light source. These findings highlight the

	potential of P3HT/TiO_2 materials as promising solutions for the purification of water from organic pollutants. [58]
Comparative Study on Photocatalytic Degradation of Mono Azo Dye Acid Orange 7 and Methyl Orange under Solar Light Irradiation	The study aimed to compare the rate of degradation of two azo dyes (Acid Orange 7 and Methyl Orange) using titanium dioxide and sunlight. It was found that Acid Orange 7 degraded faster and more easily than Methyl Orange. Furthermore, the dyes were not only decolorized but also broken down into mineral substances upon continuous exposure to sunlight[59]

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Chapter Two

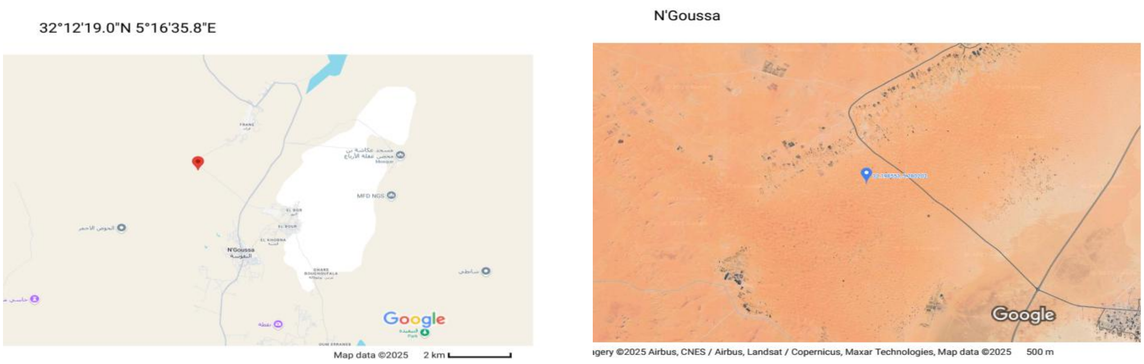
Experimental Materials and Methods

III.Introduction

In this section, we covered the various methods of work used and the set of measurements we will conduct on the sample, where we discussed the set of spectroscopic techniques that will be used to diagnose the samples, mainly represented by Fourier Transform Infrared Spectroscopy (FTIR), analysis using Scanning Electron Microscopy (SEM) Powered by technology(EDX), and the UV-Visible Spectrophotometer

III.1. the study area:

We conducted this study on a sample of dune sand from the (Fran) area located in the municipality of (N'Goussa) in the state of Ouargla. Figure(III-15)



Figure(III-1): The geographical location of the area according to the Google Maps application

III.2. Materials:

III.2.1. Used materials :

The compounds and materials used throughout all stages of work have specifications and analytical properties outlined as follows:

Table (III -1): Table of Materials Used

Materials	Purity,	Company Name
Methyl Orange	Powder (99%)	BIOCHEM
Magnesium oxide	powder (99%)	MERCK
Copper oxide	powder (99%)	MERCK
Hydrochloric acid	Solution (0.1M)	MERCK
Sand	-	-

- All analyses in the study were obtained using distilled water.

III.3.equipment and techniques :

1. The centrifuge of (nuve NF 1200) type is a device used to separate the components of a mixture in a test tube, where the solid part (the precipitate) settles at the bottom and the liquid part at the top. This separation is achieved through centrifugation at a rotational speed of up to 9000 revolutions per minute. Figure(III-16)

Figure(III-2): centrifugeuse

2. The magnetic stirrer is used to stir prepared solutions and make them homogeneous. Figure(III-17)

Figure(III-3): The magnetic stirrer

III.3.1. FTIR Infrared Spectroscopy:

FTIR Spectroscopy ,is one of the branches of spectroscopy that deals with the infrared region of the electromagnetic spectrum, where the infrared spectrum lies between the visible spectrum and the microwave spectrum. This technique allows for the identification of chemical bonds involved in the molecular structures of organic and inorganic materials, as well as crystalline and non-crystalline substances, without affecting their properties.

The chemical bonds involved in the molecular structures of organic and inorganic materials, as well as crystalline and non-crystalline substances, without affecting their properties.Infrared radiation covers a wide range of the electromagnetic spectrum as a whole and is divided into three regions . [1]

-Near-infrared 400-12820: It is closer to visible light, specifically to the color red.

-Far infrared C3 400, which is closest to microwave radiation.

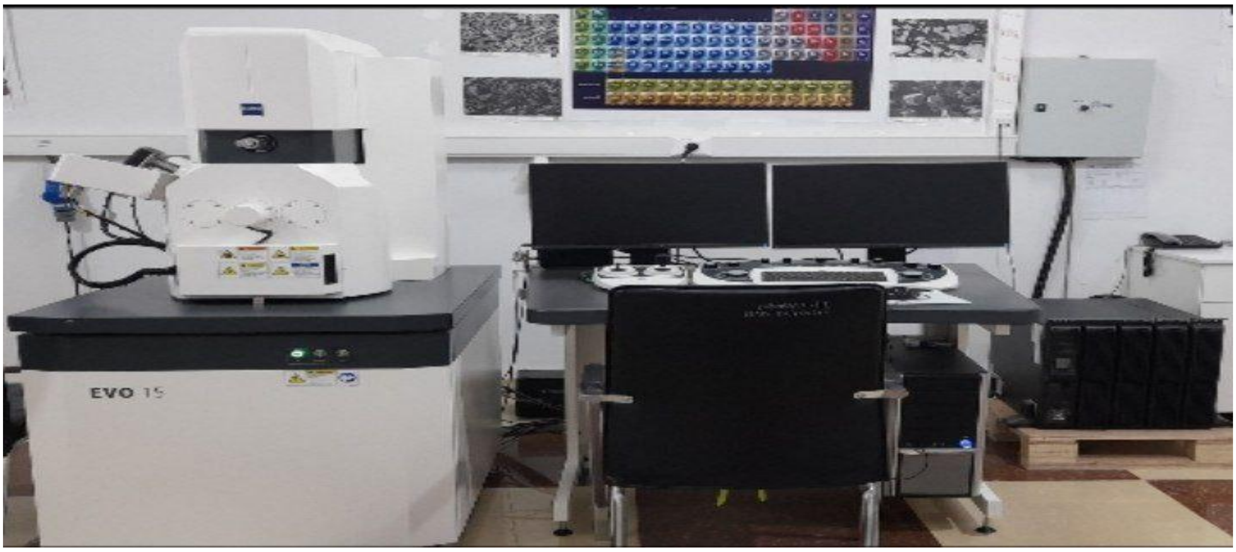
-Mid-infrared rays Cm 400 4000, which are located between the two previous regions.

Figure(III-18)

Figure(III-4): FTIR infrared spectrometer

III.3.2. Scanning Electron Microscopy (SEM) technique:

The Scanning Electron Microscope (SEM) is a type of electron microscope that produces high-resolution images of a sample's surface and has many primary and important applications in the field of materials science. The main function of this device is to generate various signals containing information about the surface topography and composition, and to examine the structural properties of the studied materials, where the sample appears in three dimensions and is characterized by its magnification capability. Figure(III-19) [2]



Figure(III-5): Scanning Electron Microscopy (SEM)

III.3.3. Visible and Ultraviolet Spectrophotometer (UV-Vis):

The Agilent Cary 100 UV-Visible Spectrophotometer is a high-performance instrument designed for precise and accurate measurements of absorbance and transmittance in the ultraviolet-visible (UV-Vis) region.

The instrument is controlled by Agilent Cary Win UV software, which allows for easy and intuitive operation, as well as advanced data processing and analysis capabilities. The software also includes a variety of measurement modes, including photometric, spectral, time-based, and kinetics modes, making it suitable for a wide range Figure(III-20).

Figure(III-6): spectrophotomètre uv/visible

III.3.4. Granular grading:

The grain size distribution test refers to the dry mechanical sieving by passing a sand sample through a set of standard sieves that differ from each other in the sizes of their openings. The sieves are arranged in descending order from the largest to the smallest. The sample is placed on top of the sieve, and then sieving is conducted using a mechanical vibrator or by hand for no less than ten minutes, which is sufficient to separate the grains of different sizes from each other. The purpose of this experiment is to determine the different percentage ratios of the various diameters of the sand grains. Figure(III-21) [4]

a) Drying oven

b) sieves

c) Electronic balance

Figure(III-7): Tools used in granular gradation

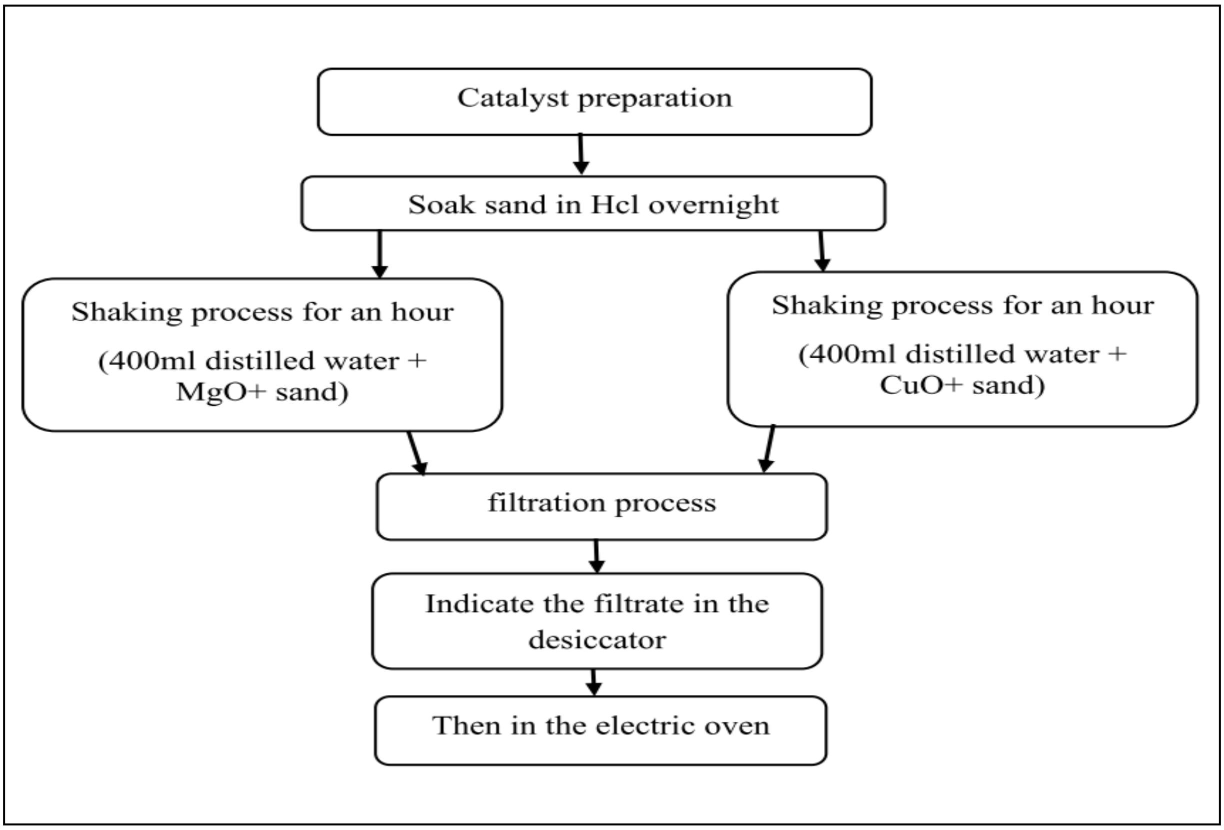
III.4.action plan :

III4.1.Preparation of solutions :

The stock solution of methyl orange with a concentration of (10^{-4}) and a volume of (V=250ml) was prepared using distilled water and two 250 ml volumetric flasks. Each flask was wrapped in aluminum foil to prevent the solution from being exposed to light.

III.4.2.Phase One: Catalyst Preparation :

At this stage, we prepared the catalyst using magnesium oxide (MgO) and copper oxide (CuO). This was done after weighing a quantity of the oxide using an analytical balance. This quantity is placed in a beaker containing 400ml of distilled water, then stirred with a magnetic stirrer for 20 minutes. After that, we add sand (sand treated with HCl) while continuing to stir. We filter the solution, place the residue in the dryer, and then in the electric oven for 4 hours at a temperature of 500°C degrees. Figure(III-22)



Figure(III-8): Practical steps for making catalyst

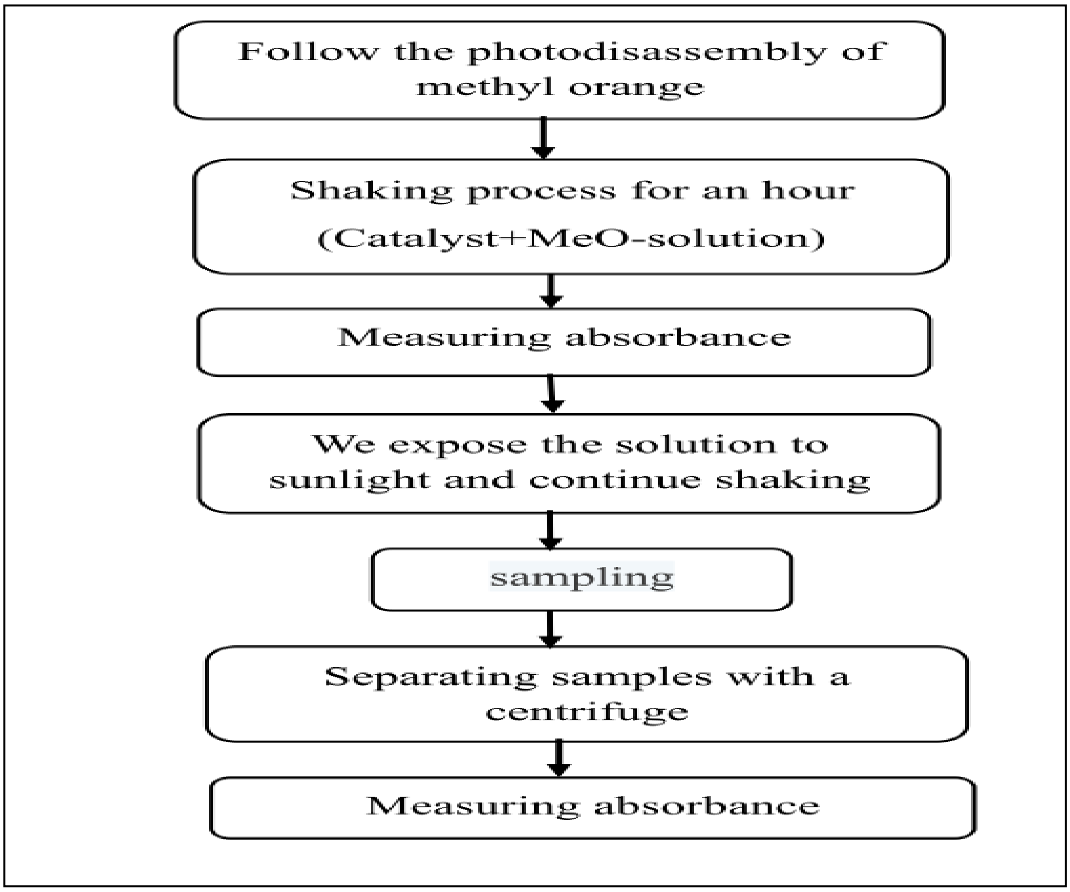
III.4.3.Phase Two: Testing the Photodegradation Process :

After the manufacturing stage, we applied the photodegradation process to study the

effectiveness of the synthesized catalyst. We placed 20ml of the methyl orange solution in a beaker along with a quantity of the catalyst. The beaker was then placed on a magnetic stirrer and exposed to sunlight.
After a period of time, we noticed a decrease in the intensity of the orange methyl color.

III.4.4.Phase Three:

In this stage, we tracked the photodecomposition kinetics of methyl orange. We placed 100ml of a methyl orange solution with a concentration of (5×10^{-5} mol/l) in a beaker, then added a quantity of the catalyst. The beaker was wrapped in aluminum foil to prevent exposure to light, and it was shaken for an hour. This step was performed to demonstrate that no adsorption occurs and that it does not significantly affect the concentration. After the hour, the solution was exposed to sunlight, and a sample was taken at specified time intervals.
The samples are placed in a centrifuge to separate the solid phase (the catalyst) from the liquid, and finally, the solution is taken for analysis using a UV/visible spectrophotometer to measure absorbance .This stage is applied with both oxides. Figure(III-23)



Figure(III-9): Scientific steps for photocatalytic decomposition of the pollutant (MeO)

Figure(III-10): Photo of a photocatalysis study of CuO-sand ,MgO-sand catalyst

[4]بضياف, & سميحة. تحديد التركيب الجزيئي للأصناف الحبيبية المختلفة لرمل كثبان منطقة ورقلة و حساب تركيز الكوارتز فيها باستخدام التقنيات الطيفية, (Doctoral dissertation) جامعـــة قاصـــدي مربـــاح ورقلـــــة.

[1] Boulmokh, A., Berredjem, Y., Guerfi, K., & Gheid, A. (2007). Kaolin from Djebel Debbagh Mine, Guelma, Algeria. Research Journal of Applied Sciences, 2(4), 435-440.

[2] paqueton.,h., & ruste,j . (2006). Microscopie électronique à balayage Principe et équipement. *Techniques de l'ingénieur. Analyse et caractérisation*, (P865v2).

Chapter three

Results and discussion

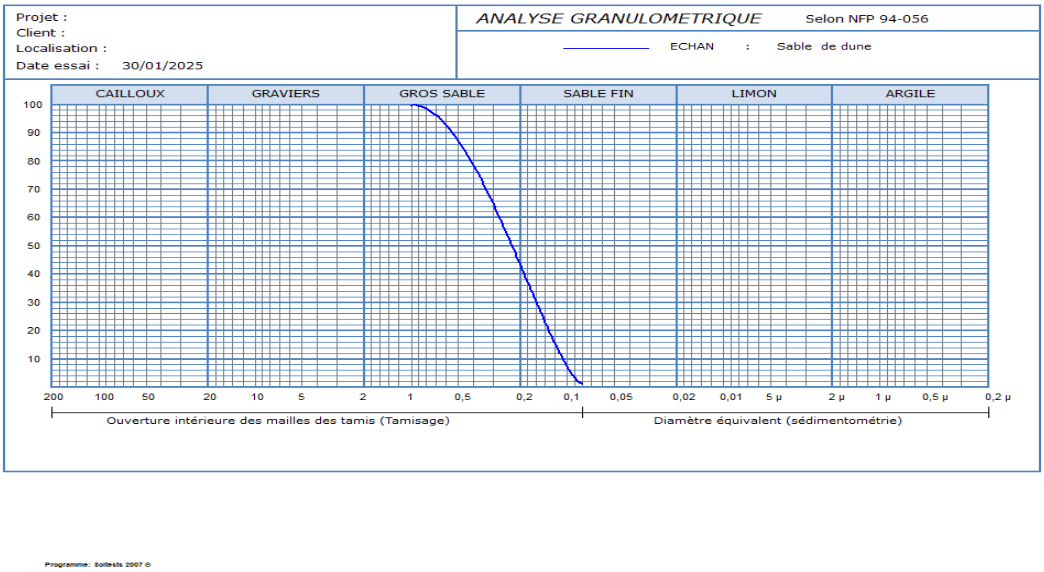
IV.Results and discussion:

This chapter aims to analyze and discuss the results reached through the study

IV.1.Results of the Grain Size Distribution Experiment:

The results of the granulometric analysis showed that the studied sand sample consists of two phases: coarse sand with a grain size range between (1mm-0.2mm) and fine sand with a grain size range between (0.2mm-0.09).

It also shows that the sand sample does not contain gravel or clay.



Figure(IV-1): Grain Size Distribution of Dune Sand from the Faran Area

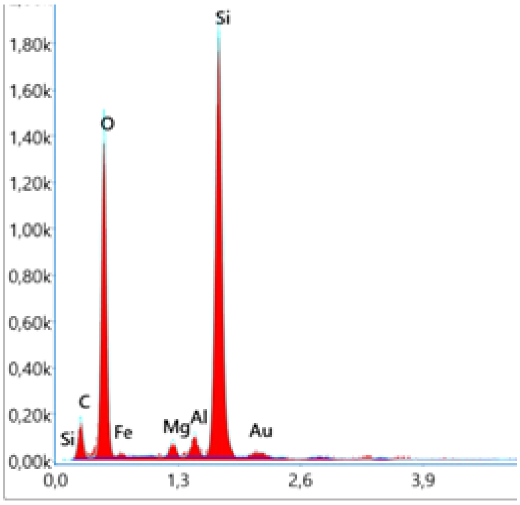
IV.2.Results of the Scanning Electron Microscope (SEM) :

The images (A) and (B) show an enlarged view of the sand from the Fran area using a scanning electron microscope (SEM) at scales of 100 micrometers and 200 micrometers, respectively. The images reveal that the sand contains various shapes, including spherical, flat, elongated, and irregular forms, with multiple sizes, both small and large.

IV.2.1.Results of the EDX analysis:

Moreover, the quantitative and qualitative analysis using EDX technology alongside the SEM device provides us with the main chemical elements constituting the sand sample and their percentages.

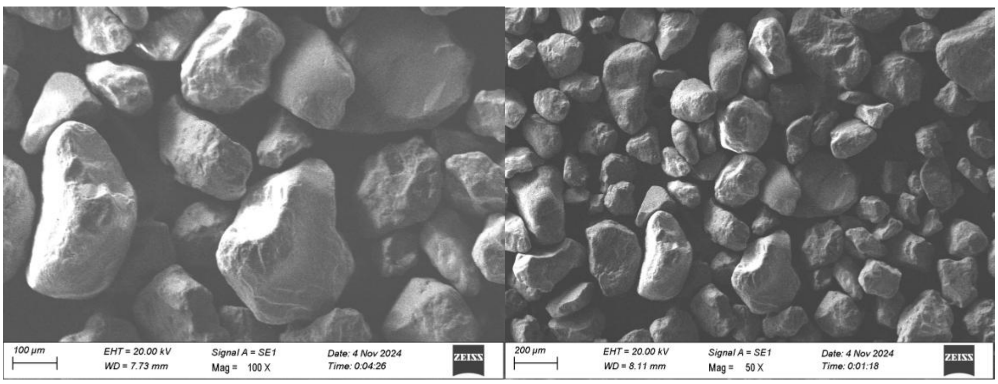
It showed that the studied sand sample contains a higher percentage of oxygen at 48.49%, 23.60% of silicon, and a significant amount of carbon at 15.36%, with the remaining elements present in smaller percentages: magnesium at 1.18%, aluminum at 1.48%, and iron at 1.45%. Where we observed the consistency of the grain size distribution test results with the results from the scanning electron microscope.



Elément	% de masse
C K	15.36
O K	48.49
MgK	1.18
AlK	1.48
SiK	23.60
FeK	1.45

Figur(IV-2): EDX analysis spectrum of the Fran zone sand sample and analysis results thereof

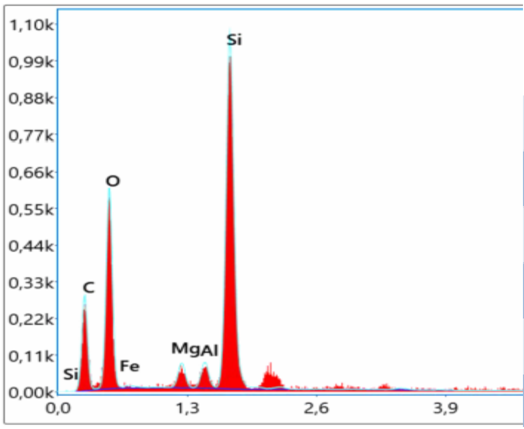
(a **(**b



Figure(IV-3): Scanning electron microscope image of a sand sample in the Fran area

IV.2.2.SEM scanning electron microscope results and EDX analysis results for the Sand_MgO catalyst

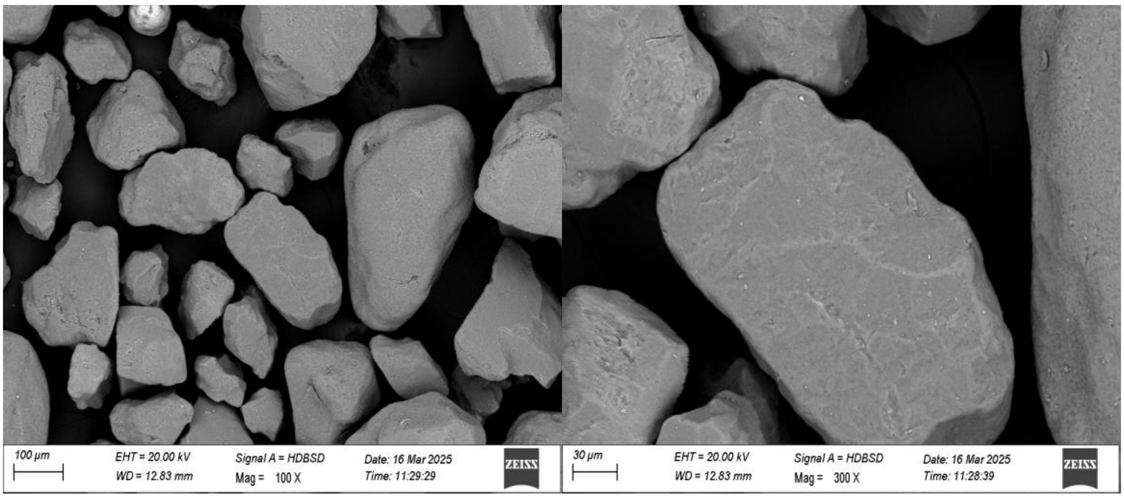
Images (a) and (b) show a magnified view of the oxide-treated sand using a scanning electron microscope (SEM) at a scale of 30nm and 100nm respectively. From both images, we observe oxide deposition on the sand grains. Moreover, quantitative and qualitative analysis using EDX technology, combined with scanning electron microscopy, confirmed a change in the proportions of the chemical elements of sand, as the percentage of Mg increased by 1.30%, and changes occurred in the proportions of the rest of the elements



Elément	% de masse
C K	38.30
O K	44.88
MgK	1.30
AlK	1.10
SiK	13.34
FeK	1.08

Figure(IV-4): EDX analysis spectrum of the sand_MgO catalyst and its analysis results

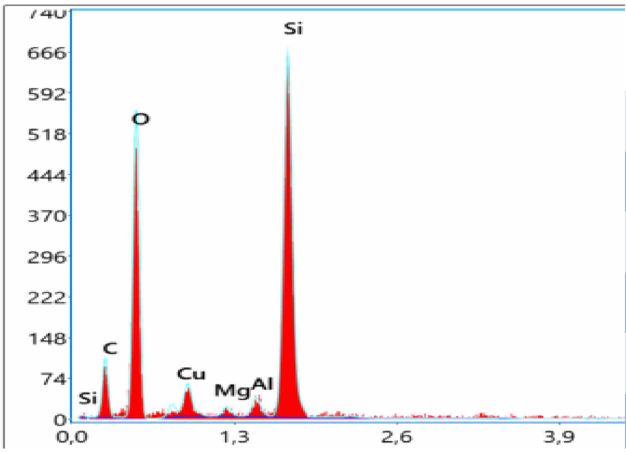
(a **(**b



Figure(IV-5): Scanning electron microscope image of the sand_MgO catalyst

IV.2.3.SEM scanning electron microscope results and EDX analysis results for the Sand_CuO catalyst

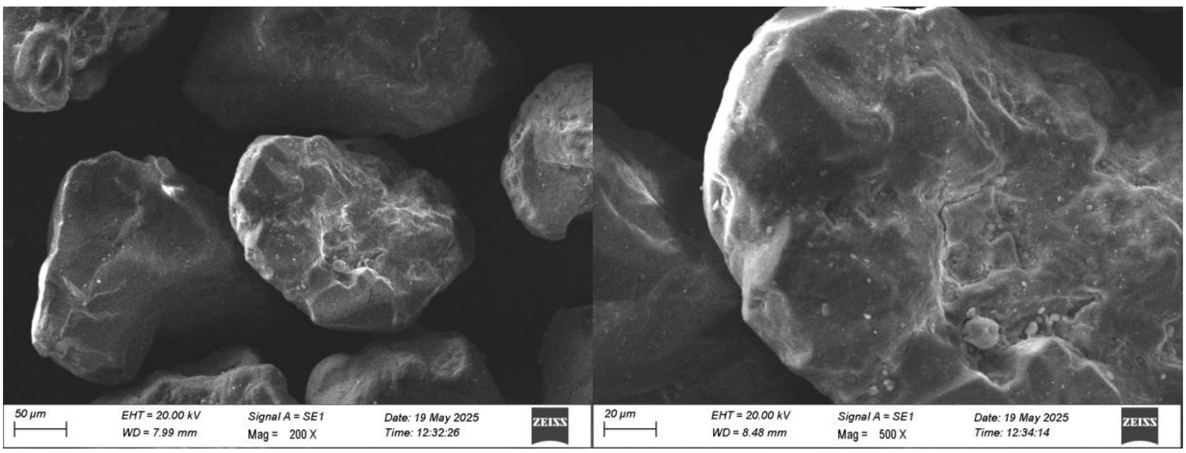
Images (a) and (b) show a magnified view of the oxide-treated sand using a scanning electron microscope (SEM) with a scale of 20nm and 50nm respectively. From both images, we observe oxide deposition on the sand grains. Moreover, quantitative and qualitative analysis using EDX technology, combined with scanning electron microscopy, confirmed a change in the proportions of the chemical elements of sand, as we observed the appearance of the element Cu at a rate of 3.07% and changes in the proportions of the rest of the elements



Elément	% de masse
C K	25.71
O K	54.03
MgK	0.61
AlK	0.93
SiK	15.65
CuK	3.07

Figure(IV-6): EDX analysis spectrum of the sand_CuO catalyst and its analysis results

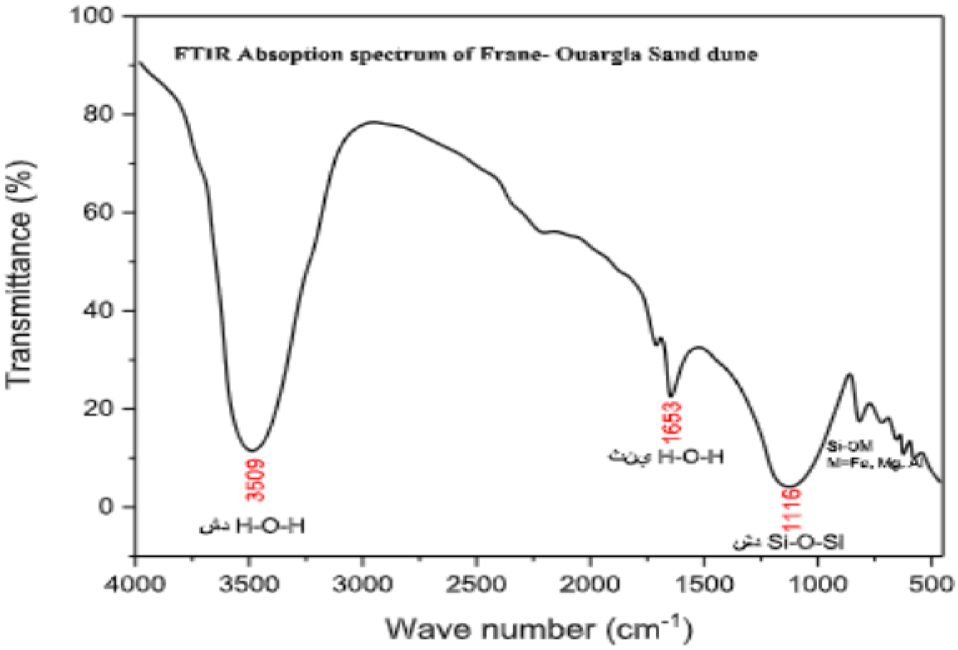
(a (b



Figure(IV-7): Scanning electron microscope image of the sand_CuO catalyst

IV.3.Discussion of the results of infrared absorption spectroscopy (FTIR) :

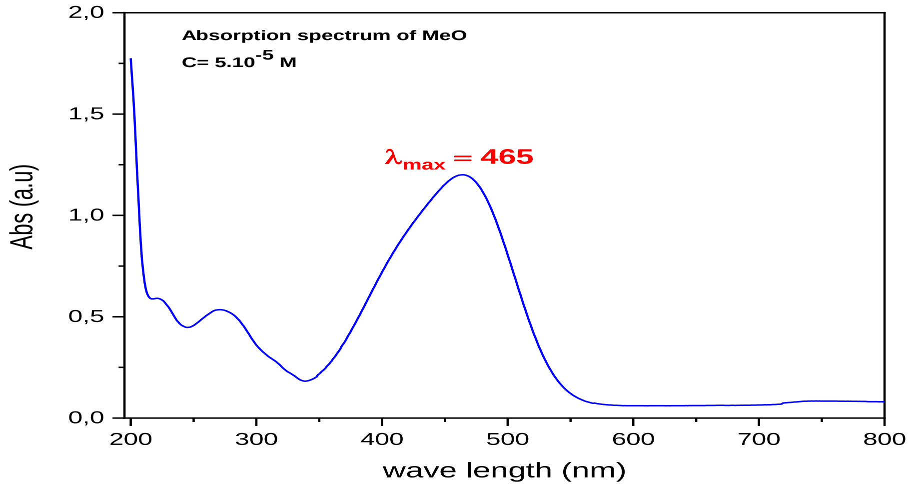
The results of the FTR spectroscopy analysis show that the sample contains a high percentage of quartz, which is confirmed by the absorption band at approximately 1116, corresponding to the stretching vibration of the Si-O bond. Additionally, the absorption spectrum indicates the presence of water in the sample, as evidenced by the absorption band at approximately 3509, corresponding to the OH bond vibration in water, and the absorption band at approximately 1653, corresponding to the bending vibration of the H-OH bond. It is also confirmed that there are very low percentages of metal oxides, with very weak absorption bands extending from about 8081 to 495, which confirm the presence of oxides represented by Fe, MgO, and AlO.



Figure(IV-8): Infrared absorption spectrum of a Fran sand sample

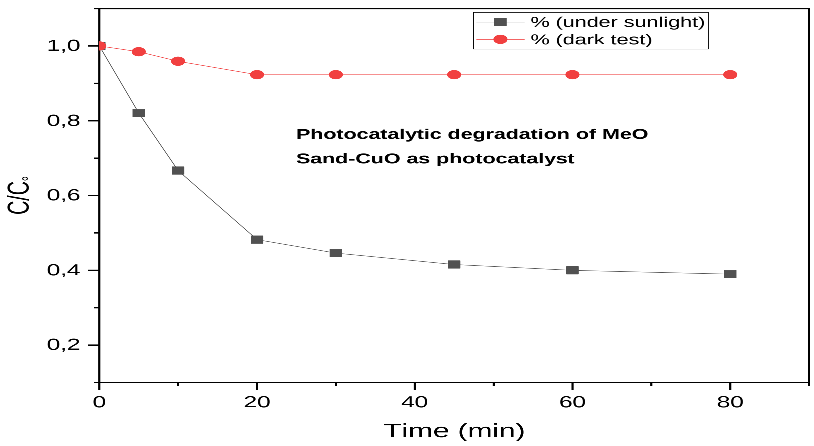
IV.4.Spectroscopic Study of Methyl Orange:

We observe slight absorption in the ultraviolet range and maximum absorption in the visible range at 465nm, as shown in the figure.



Figure(IV-9): Absorption spectrum of methyl orange at concentration $C=5.10^{-5}$ M

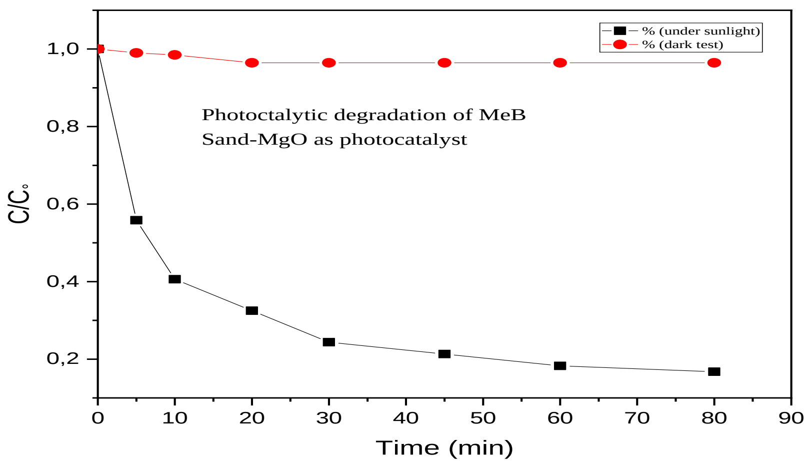
The results obtained showed that the degradation rate of the organic pollutant (MeO) during the first 20 minutes was high, reaching a degradation percentage of 49%. After 80 minutes of the photocatalytic process, an increase in the degradation percentage was observed, reaching 65%.



Figure(IV-10): Dissociation curve of the organic pollutant (MeO) in the presence of the Sand_CuO catalyst

The obtained results showed that

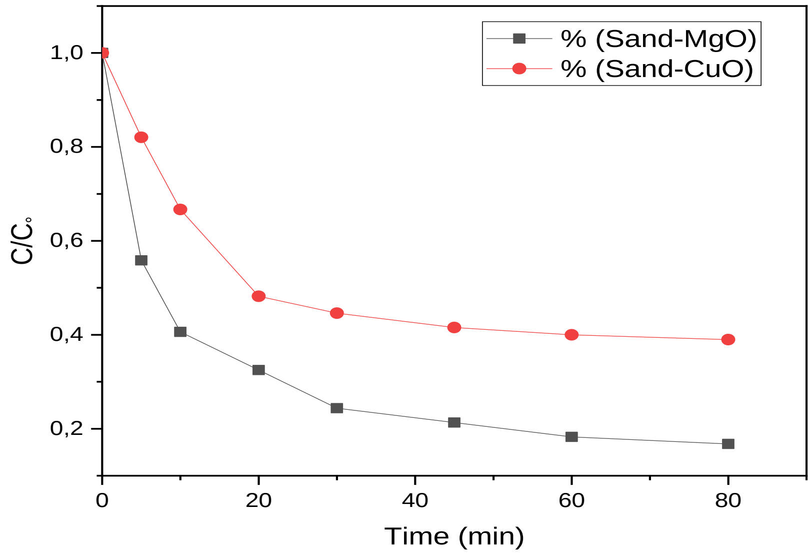
The degradation rate of the pollutant during the first 20 minutes was very high, reaching about 60% in this short period. After 80 minutes of the photocatalytic process, the degradation rate reached about 80%.



Figure(IV-11): Dissociation curve of the organic pollutant (MeO) in the presence of the Sand_MgO catalyst

IV.5. Comparison of MgO and CuO decomposition rates:

We observe a high decomposition rate of the pollutant during the first 20 minutes in both the kinetic curves of MgO and CuO. Despite this, MgO showed greater decomposition, with the decomposition rate ranging from 49% to 60%. Then, after 80 minutes of the photocatalytic process under sunlight, we observe nearly complete decomposition in the presence of the Sand_MgO catalyst, and Sand_ CuO catalyst, the decomposition rate does not exceed 65%



Figure(IV-12): Curve comparing the dissociation speed of the organic pollutant in the presence of Sand_MgO and in the presence of Sand_CuO

These results can likely be explained by the fact that the effective surface area of the Sand_MgO photocatalyst is more active than the effective surface area of the Sand_CuO photocatalyst

General summary

General summary

In this work we have been able to manufacture a photocatalyst from a natural material where in the Ouargla region, rich in sand and sun, sand represents a valuable natural resource that can be used as a support in photocatalytic processes to treat polluted water. In applying photocatalytic disassembly technology, we relied on available, low-cost local resources, which contribute to the development of sustainable and cost-effective solutions

We relied on a group of techniques, which were represented by the grain gradient technique, the scanning electron microscope (SEM) technique attached to the EDX technique, the infrared spectroscopy (FTIR) technique, and the visible and ultraviolet (UV) spectroscopy technique.

The results were as follows:

- Granular grading technique: The results of the granular analysis showed that the sand sample studied consists of two phases: coarse sand after granular sand confined between (1mm_0.2mm) and fine sand confined between (0.2mm_0.09)

Scanning electron microscopy (SEM) technology attached to the (EDX) technology: Analyses have shown that the sands of the Fran area are of a variety of shapes and sizes. Chemically it consists mainly of oxygen, silicon, and carbon.

Treatment with magnesium oxide (MgO) or copper oxide (CuO) led to the deposition of these oxides on sand grains, with a noticeable increase in the percentage of magnesium (1.30%) in the case of Sand_MgO, and the appearance of copper (3.07%) in the case of Sand_CuO.

Infrared spectroscopy (FTIR) technology: built with a high percentage of quartz (absorption band at 1116)

Presence of water (with two absorption bands at approximately 3509 cm and 1653 cm)

Very small amounts of metal oxides such as iron, magnesium, and aluminum (confirmed by weak absorption bands between 808 and 495cmw)

-Visible and ultraviolet (UV) spectroscopy technology: The results showed light absorption at 465 nm and effective decomposition of organic pollutant (MeO) ranging between 49-60% in 20 minutes and 65-80% after 80 minutes

MgO excels in primary decomposition, and Sand_MgO achieves almost complete decomposition after 80 minutes under the sun

While Sand_CuO only reaches 65%.

Therefore, we can say that this technology has shown excellent results in removing methyl orange in aqueous media and encourages the continuation of this research, the completion of the study of the disintegration of pollutants, and taking the results of the work into consideration for its application in water purification plants after determining the chemical composition of the disintegration products

Summary
This work aims to manufacture a new photocatalyst using a locally abundant natural material in the region, represented by dune sand, by using it as a support material for a metal oxide to obtain the new photocatalyst. Additionally, it exploits sunlight as a clean and renewable energy source to remove some organic pollutants such as orange methyl. The analysis results showed that the used dune sand contained a significant percentage of quartz and small amounts of oxides. As for the photocatalytic degradation results using the new catalyst, Sand_MgO achieved a degradation rate of 80% within 80 minutes, while Sand_CuO had a lower efficiency, not exceeding 65% in the same time period of 80 minutes.

ملخص
يهدف هذا العمل الى تصنيع محفز ضوئي جديد انطلاقا من ماده طبيعيه محليه متواجده بوفره في المنطقه والمتمثله في رمل الكتبان باستخدامها كماده داعمه لاكسيد معدني للحصول على المحفز الضوئي الجديد اضافه الى استغلال ضوء الشمس كطاقه نظيفه ومتجدده لازاله بعض الملوثات العضويه مثل المثيل البرتقالي اظهرت نتائج التحليل احتواء الرمل الكتبان المستعمل على نسبه معتبره من الكوارتز و نسب ضئيله من الاكاسيد اما نتائج التفكيك الضوئي المحفز بواسطه المحفز الجديد ان Sand_MgO اعطى نسب تفكيك للملوث وصلت الى 80% في مدة زمنيه 80 دقيقه اما Sand_CuO كفاءته في تفكيك كانت اقل حيث لم تتجاوز 65% في نفس الفتره الزمنيه 80 دقيقه.

Résumé
Ce travail vise à fabriquer un nouveau photocatalyseur à partir d'une matière naturelle locale abondante dans la région, à savoir le sable des dunes, en l'utilisant comme support pour un oxyde métallique afin d'obtenir le nouveau photocatalyseur, en plus d'exploiter la lumière du soleil comme source d'énergie propre et renouvelable pour éliminer certains polluants organiques tels que l'orange de méthyle. Les résultats de l'analyse ont montré que le sable des dunes utilisé contenait une proportion considérable de quartz et de faibles pourcentages d'oxydes. En ce qui concerne les résultats de la dégradation photocatalytique avec le nouveau catalyseur, Sand_MgO a atteint un taux de dégradation des polluants de 80 % en 80 minutes, tandis que Sand_CuO avait une efficacité de dégradation inférieure, ne dépassant pas 65 % dans la même période de 80 minutes.

Future prospects

We hope to continue the study on the photodissociation of these new synthesized catalysts.

Completing the DRX characterization

Study of the factors affecting the decomposition rate of a pollutant to identify the ideal factors that lead to the highest decomposition rates, such as studying the pH factor, the catalyst concentration factor, the ratio of the oxide fixed on the support material, and the pollutant concentration factor.

In the near future, and why not as a PhD thesis project