Ministère de l'enseignement supérieur et de la recherche scientifique

Université Ferhat Abbas- Sétif 1

Institut : Optique et Mécanique de Précision

Département : Optique et mécanique de précision

Domaine : Sciences et Technologies

Filière : Optique et Mécanique de Précision

Spécialité: Optique et Photonique Appliquée

Mémoire de Master

Amélioration de performance du capteur environnemental à fibre optique

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Soutenue le: 03/07/2023

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CHAPTER I: ENVIRONMENTAL POLLUTANTS

CHAPTER III: EXPERIMENAL PART

Abstract

Water pollution can have serious consequences on both human health and the environment, so it is essential to prevent and mitigate these impacts. This major issue necessitates the development of novel technologies to continually and in situ manage water quality.

Optical methods are one of the techniques used to detect and monitor water quality; they are used to detect pollutants in water by analyzing a light beam after passing through the medium to be analyzed. This technique is based on the measurement of intensity, absorption, refractive index, and other parameters.

Methyl Orange was chosen as a model pollutant in the monitoring of polluted water in our experiment because it is commonly used as an acid-base indicator and has multiple interpretations.

The geometry of the fiber is changed into a U-shaped design for testing Methyl Orange (MO) at the laboratory of applied optics to enhance the sensitivity of the optical fiber sensor (FOS). This design allows for a larger interaction between the evanescent field and the surrounding medium, which has better sensitivity compared to a straight one, making it more suitable for accurately monitoring MO concentration changes in distilled water.

The main objective of this thesis is to achieve an optical fiber sensor working in the visible range for detecting pollutants in water, and develop a technique based on the analysis of a light beam after passing through the medium to be analyzed which can measure parameters such as intensity, absorption, refractive index, and so on.

Résumé

La pollution de l’eau peut avoir de graves conséquences pour la santé humaine et l’environnement, il est donc essentiel de prévenir et d’atténuer ces impacts. Cette question majeure nécessite le développement de nouvelles technologies pour gérer en permanence et in situ la qualité de l’eau.

Les méthodes optiques sont l’une des techniques utilisées pour détecter et surveiller la qualité de l’eau. Ils sont utilisés pour détecter les polluants dans l'eau en analysant un faisceau de lumière après avoir passé par le milieu à analyser. Cette technique est basée sur la mesure de l’intensité, l’absorption, l'indice de réfraction et d’autres paramètres.

L’orange de méthyle a été choisi comme polluant modèle dans la surveillance de l’eau polluée dans notre expérience car il est couramment utilisé comme indicateur acido-base et a plusieurs interprétations.

La géométrie de la fibre est transformée en une conception en forme d'U pour tester l'orange méthyle (MO) dans le laboratoire de l'optique appliquée. Pour augmenter la sensibilité du capteur de fibre optique (FOS). Cette conception permet une plus grande interaction entre le champ évanescent et le milieu qui a une meilleure sensibilité par rapport à l’uniforme fibre, ce qui le rend plus adapté pour surveiller avec précision les changements de concentration de MO dans l'eau distillée.

L’objectif principal de cette thèse est d’obtenir un capteur de fibre optique fonctionnant dans le domaine visible pour détecter les polluants dans l’eau, et de développer une technique basée sur l’analyse d’un faisceau de lumière après avoir passé par le milieu à analyser qui peut mesurer des paramètres tels que l’intensité, l’absorption, l'indice de réfraction, etc.

الملخص

يمكن أن يكون لتلوث المياه عواقب وخيمة على صحة الإنسان والبيئة، لذلك من الضروري منع هذه الآثار والتخفيف منها. تتطلب هذه القضية الرئيسية تطوير تقنيات جديدة لإدارة جودة المياه بشكل دائم وفي الموقع.

تعتبر الطرق البصرية إحدى التقنيات المستخدمة للكشف عن جودة المياه ومراقبتها. يتم استخدامها للكشف عن الملوثات في الماء عن طريق تحليل شعاع من الضوء بعد المرور عبر الوسط المراد تحليله. تعتمد هذه التقنية على قياس الشدة والامتصاص ومعامل الانكسار ومعايير أخرى.

تم اختيار برتقال الميثيل كنموذج ملوث في مراقبة المياه الملوثة في تجربتنا لأنه يستخدم بشكل شائع كمؤشر حمضي قاعدي وله عدة تفسيرات.

يتم تحويل هندسة الألياف إلى تصميم على شكل حرف U لاختبار الميثيل البرتقالي في مختبر البصريات التطبيقي. لزيادة حساسية مستشعر الألياف الضوئية .يسمح هذا التصميم بتفاعل أكبر بين المجال الزائل والوسط الذي يتمتع بحساسية أفضل مقارنة بالألياف المنتظمة، مما يجعله أكثر ملاءمة لمراقبة التغيرات في تركيز برتقال الميثيل في الماء المقطر بدقة.

الهدف الرئيسي من هذه الأطروحة هو الحصول على مستشعر من الألياف الضوئية يعمل في النطاق المرئي لاكتشاف الملوثات في الماء، وتطوير تقنية تعتمد على تحليل شعاع من الضوء بعد مروره عبر الوسط المراد تحليله والذي يمكن قياسه. معلمات مثل الشدة، الامتصاص، معامل الانكسار، إلخ.

General introduction

The environment refers to the natural world around us, including clean air, water, land, and living organisms. Pollution is the negative change that occurs to one of the components of the environment, which results, in whole or in part, from vital and industrial human activity. In comparison with the natural situation that prevailed before human intervention, it begins to manifest in energy changes, different radiation levels, and unwanted biological, physical, and chemical alterations that occur in the biosphere surrounding us. In this sense, environmental pollutants are numerous and varied, originating from different sources and having various meanings and effects."

The presence of physical, chemical, or biological substances in water, soil, and air that are damaging to our health, safety, and plant and animal life is referred to as environmental pollution. Economic activities are necessary for society's growth; however, many of these activities constitute a persistent source of pollution, resulting in significant environmental and economic consequences

Water is one of the most important natural resources available in any economic structure, as it is the basis of life and development for any society. It is impossible to imagine the existence of life on the surface of the Earth without the presence of water.

Water is an essential resource that sustains life on Earth. It is used for drinking, irrigation, sanitation, and industrial purposes. However, the importance of water goes beyond its basic usage. It plays a crucial role in maintaining the balance of ecosystems, regulating the climate, and supporting biodiversity.

Unfortunately, water pollution has become a significant threat to the availability and quality of this vital resource. Polluted water not only affects human health but also has severe consequences on the environment. The majority of issues that humanity has faced in recent years are related to water quantity and quality (UNESCO, 2009). That is the main reason which necessitates water purification, treatment, and monitoring, making it necessary to protect the community before consumption

As a resource, water not only plays a part in sustaining life, but it also plays a fundamental role in ecosystem support, economic recovery, and development, as well as community and social well-being. [1].

Currently, about 20% of the world's population lacks access to safe drinking water. While water is a renewable resource, it is also a finite resource. Only 3% of the world's water is fresh, of which one-third is inaccessible [2].

Water is under pressure from increasing pollution, which is a growing concern in many countries worldwide, where 1.1 billion people are unable to access safe water for drinking purposes. Additionally, 2.5 billion people lack proper sanitation. It is expected that two-thirds of the world's population will live in countries with moderate or severe water crises by 2025, according to the event of World Water Day (2002). In addition, it was highlighted how essential it is to have access to high-quality drinking water.

Among the optical techniques for detecting water pollutants, optical fiber sensors are included. In this thesis, we will achieve an optical fiber sensor that works in the visible range for detecting pollutants in water. This technique is based on the analysis of a light beam after it passes through the medium to be analyzed, utilizing an evanescent absorption wave. It involves the measurement of intensity, absorption, refractive index, and other parameters.