The study of Laser 532nm wavelength in Ni\textsuperscript{2+}·H\textsubscript{2}O for reflective effect

Hao-Lin Zhou, Xin-Da Wu *, Dan Lin, Li-Qiong Zhang

School of Chemistry and Materials Engineering, HuiZhou University, China
Corresponding author E-mail:13478511396@139.com and wutomp@hzu.edu.cn

Abstract. The rapid development of science and technology in china, treatment of pollutants is also relatively the biggest problem in developed countries, and heavy metal pollution in many water pollution accounted for a larger proportion. The traditional analytical sampling methods include ultraviolet spectrophotometry (UV), atomic absorption spectrometry (AAS) and atomic fluorescence spectrometry (AFS), to improve timeliness, in this study, laser light method was used to preliminarily analyse the water body, using the difference of reflected facula analysis may contain metal ions in the sample. It was found that after the laser with the wavelength of 532nm was refracted in the nickel solution and distilled water, the facula reflected by the outer glass surface had a significant deviation, from the preliminary experimental results, the reflect facula area of that nickel liquid was 96.01% with respect to water. Therefore, that lase light can be used as a reference for research on miniaturize measurement equipment in the future.

Keywords: Laser light, Metal ion, Underwater laser propagation, Refractive index, Wastewater ion analysis.

1. Introduction
In recent years, the rapid development of science and technology in china, multi scientific research conditions and international technology on the same track, treatment of pollutants is also relatively the biggest problem in developed countries, the water pollution problem is increasingly serious, and heavy metal pollution in many water pollution accounted for a larger proportion. Because heavy metals are toxic and easily enriched and expanded in biological chains, human as the top of the food chain, there is a greater risk of heavy metal poisoning. Minamata disease in the international is a more famous case in modern times, minamata bay fish and shrimp because of industrial wastewater pollution, and these contaminated fish and shrimp are eaten by animals and humans, to neurasthenia syndrome, acute renal failure and other diseases. Traditional metal ion analysis methods include ultraviolet spectrophotometry (UV), atomic absorption spectrometry (AAS), atomic fluorescence spectrometry (AFS) and other methods. to improve timeliness, this study will break through the traditional analysis methods for polarized light metal ions, can timely understand the condition of ions in water. Reference could be made to the research on recovery of low concentration copper ions and green treatment of abandoned street trees by Shinn-Dar Wu and Wen-Na Hu et al. in 2020. Their study addresses the cost-effective recovery of low-concentration copper solutions and the pollution of air and groundwater by traditional methods of treating street trees, provide solutions for industrial copper wastewater treatment and environmental protection\textsuperscript{[1,2]}. In optical research, the measured data indicate that the refractive index and optical attenuation coefficient of the laser in different salt solutions and liquids with different concentrations are different and have significant regularity\textsuperscript{[3-7]}. Studies have used
refractive index differences at different concentrations to obtain measurements of solution concentration by analysing the refractive index [8-11]. In the above background, it is very necessary to detect and reuse the wastewater in industry, or to detect the heavy metal ions that may be contained in the drinking water in life. However, since these detection instruments are bulky, expensive and difficult to use, a high level of expertise from the user is required. Usually, water samples need to be sent to professional laboratories and testing institutions for sampling and testing, which is difficult to detect water samples in daily life. In this study, the laser light method was used to preliminarily analyse the water body, and the difference of faculas was used to analyse the metal ions that might be contained in the samples, which can greatly reduce the size, operation difficulty, cost and other aspects, has a wide application prospect in the future.

Figure. 1 Recovery butter technology process

In this study, the metal ions in the battery waste liquid before and after the treatment of finished product No.3 in Fig1 water treatment were qualitatively detected, judge whether there are a lot of recyclable metal ions in the waste liquid before and after recovery.

2. Experimental design
The experimental process of this study is for battery recycling waste liquid, residual analysis of water sample after separation of metal ions (M⁺), as shown in Fig 2.

Figure. 2 Experimental process
Such as Fig1 sewage system metal ion refraction characteristic analysis experimental process, according to the battery waste sampling metal ions as the main analysis, and consider the results of physical properties of traditional $M^+$ polarized light known from previous literature, to design this experiment. In this experiment, the green laser (power 100mW, wavelength 532nm) was used to irradiate the samples, and the actual measurement of the reflected light phenomenon was done, sample group containing distilled water, nickel waste liquid (containing nickel 20%), cuvette (7.5*12.5*45mm) used as a liquid container.

2.1. Direction of light in liquid based on theory
According to theory, the light distribution after refraction in water is shown in Fig3

![Figure. 3 Theoretical light path map](image)

According to the research of LIU Hai-shan et al. the glass wall of a square container is equivalent to a parallel plate, when the light passes through the flat glass, it does not change the propagation direction of the light, nor does it change the angle between the light and the interface of the measured liquid, so the influence of glass on the direction of light propagation can be neglected [8]. Fig 3 shows the difference in refractive index caused by different media. When the light source is used to illuminate the wall directly, such as the red line, it is used as a blank group to discuss the refraction of light in other media. When that light source is inject into 20% nickel liquid at a horizontal angle $\theta$, because the refractive index of nickel liquid is different from that of air, the light is deflected. Results the position of the light's landing facula A on the wall and the blank group's landing facula B are different.

3. Experimental analysis and discussion
In this experiment, the physical properties of laser passing through $M^+$ are discussed by means of actual reflection and reflection measurement, as shown in Fig 4. The light source was placed on the shelf 15cm away from the sample at an included angle of about 40 as shown in Fig4, and the lamp source switch was turned on, the facula of laser light reflected by the sample was recorded in CMOS (honor 9x-imx 582), the differences in the shape and size of the reflected faculas are found and discussed. In view of that effect of the presence of stray light on the reflect facula, the measured facula is not a regular circle, so this experiment in the facula for the largest circle (ellipse), and calculate the area of the circle, the experimental calculation area of the software used for Image J, and finally found that when the light source is refracted by different liquids, the facula area is different, and the specific difference is described by the area ratio, the area ratio is obtained by comparing the facula measured by the sample to the facula reflected without passing through the liquid.
The light source shines on 20% nickel solution, and not all the light will pass through the cuvette, which will be reflected back on the glass surfaces on both sides, forming a facula A and a facula B on the desktop. As shown in Fig 4, Analysis of the facula formed after the light source is reflected by the glass surfaces on both sides, facula B is formed after reflection from the outer glass surface. Since it does not pass through the sample solution, it has no practical measurement significance, so do not discuss this. The facula a marked by a red circle in Fig 4 is a facula formed after laser light is reflected by nickel liquid, the position and shape of the measured facula is not the same as the facula formed without passing through the sample due to scattering and loss of light in the liquid.

3.1. Direction of light in liquid based on theory
As shown in Fig 5, an approximate facula area is drawn by measuring the reflected facula, and an area is calculated. The theory is in Fig 3, $\theta_1 > \theta_2$, $\theta_2 > \theta_3$, resulting in the measured facula A located above the blank group facula B. At the same time, the metal ions in the solution also scatter the incident light source to other different directions. This study refers to the research of Zhang Hua et al. with the increase of solution concentration; the scattering effect of solution on laser is more obvious [3].

![Figure 4 Schematic diagram of refracted light](image)

**Figure. 4 Schematic diagram of refracted light**

![Figure 5 Facula screenshot](image)

**Figure. 5 Facula screenshot**

※ Actual reflect light ban of light passing through two set of samples

| Sample Solution | 20%Ni Solution | Distilled Water | BlankGroup |
|-----------------|----------------|-----------------|------------|
| Area (mm²)      | 2.090          | 2.177           | 2.281      |
| Area ratio      | 0.9163         | 0.9544          | 1.000      |

Table 1. Facula data summary
For example, in Fig 5 (a) and (b), by comparing the shapes and sizes of the reflect facula when the laser light passes through the nickel solution and the distilled water, there are significant differences. In this experiment, an approximate circle is made in the facula to ignore the effect of stray light on the measurement of the actual area of the facula. Image J used in software. In Fig 5 (a) and (b), the length of the cuvette is 12.5mm as a reference, as shown by the yellow line. The largest approximate circle is made within the facula indicated by the red dashed line and the relative area of the circle is calculated. The measurement results are shown in Table 1. In the two groups of experiments, the facula areas after reflection were not equal in size, and the data of the two groups were different. In this experiment, the area ratio was introduced to compare the two differences, and the test was conducted in the same way. The differences in area ratios of reflected nickel solution and distilled water could be visually compared by comparing their light with those of the blank control group.

4. Conclusion
Based on the known theory and the experimental results, it was concluded that the laser would be refracted and scattered in distilled water and nickel solution, making the measured facula size and shape different from that of the blank group. In this experiment, the specific difference was analysed by measuring the facula are. The area ratio introduced was used to compare the difference between the sample group and the blank group. It was found that the facula area ratio of the nickel solution group was smaller than that of the distilled water group, and the area ratio of the two groups of samples was less than 1. According to the preliminary experimental results, the facula area after reflection with 20% nickel solution is 96.01% of that of distilled water. More kinds and concentrations of metal ions will be measured and studied in the future, looking for different metal ion liquids, for the characteristics of ions, the difference is calculated by the area of the light reflected by the liquid, through the study of this relationship can be for the measurement of metal ions qualitative and preliminary quantitative, provide the feasibility.

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