of magnetic particles in the magnetorheological fluid. When the side length of the weir remains constant, increasing the number of sides in the geometric shape of the weir leads to a gradual reduction in the average velocity of the transient hydraulic jump, indicating a more pronounced weakening effect on the velocity characteristics of the transient hydraulic jump.

The magnetic field also has a significant impact on the height of the magnetic jet hydraulic jump. By analyzing the selection of the highest point of the hydraulic jump, it was found that when a magnetic weir is present, the highest point of the transient hydraulic jump is lower than that of a non-magnetic weir. This phenomenon is also attributed to the magnetic weir generating a magnetic field in the vertical direction, which results in the attraction of magnetic particles, reducing the height of the hydraulic jump. Typically, when the side length of the weir remains constant, increasing the number of sides in the geometric shape of the weir leads to a gradual reduction in the height of the transient hydraulic jump, indicating a more pronounced weakening effect on the height characteristics of the transient hydraulic jump.

The final research findings demonstrate that the magnetic field can exert systematic influence on the form and velocity of hydraulic jumps. By adjusting the magnetic field distribution as needed, it is possible to control the behavior of hydraulic jumps and thereby reduce internal defects in steel billets.

**УДК 338**

## 一种基于铁纳米簇的新型可视化葡萄糖传感器

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***Summary.*** *In this paper, a novel fluorescent sensor for glucose detection based on fluorescent iron clusters (Fe NCs) and glucose oxidase is developed. With the increase of glucose concentration, the red fluorescence of iron nanoclusters decreases gradually, and the glucose content can be detected in the range of 0–100 μmol·L⁻¹. In addition, in order to facilitate the detection of glucose, this paper investigated the coating of Fe NCs and glucose oxidase by agarose and further preparation of agarose gel test strip for glucose detection. Under ultraviolet lamp, the change of glucose content can be identified through the color change of agarose gel.*

The application of glucose testing in biomedicine is of great significance. In clinical medicine, diabetes mellitus seriously jeopardizes human health, and its diagnosis and treatment has been a major challenge in the medical community. Diabetes can be effectively monitored and treated by accurate measurement of glucose content in diabetic patients. Currently, enzyme biosensors for measuring glucose content can be categorized into electrochemical enzyme biosensors,

photochemical enzyme biosensors, and other biosensors. Among them, photochemical enzyme biosensors have received widespread attention in recent years due to their advantages of high detection sensitivity, good selectivity, simple operation, fast response speed, and no need for complex pre-processing. Herein, we proposed a novel assay system containing Fe NCs and glucose oxidase, and made agarose gel detection strips for the visual fluorescent detection of glucose.

The Fe NCs prepared with hemin as main raw material not only had good water solubility and bright red fluorescence, but also showed super-sensitive response to hydrogen peroxide ($H_2O_2$). This paper showed that we added Fe NCs as catalyst into the reaction system composed of o-phenylenediamine (OPD) and $H_2O_2$. $H_2O_2$ can be converted into hydroxyl radical (·OH), ·OH can quickly quench the red fluorescence of Fe NCs at 616 nm. OPD will be quickly oxidated by OH to generate its oxidized product OPDox that exhibits bright yellow fluorescence around 565 nm. As shown in fig. 1, *a*, we investigated the effect of various concentrations of Fe NCs on the fluorescence of OPD-$H_2O_2$ system. It could be found that with the increase of Fe NCs concentrations, the fluorescence emission peak around 565 nm attributed to OPDox enhanced gradually. Similarly, fig. 1, *b*, presented the fluorescence emission spectra of Fe NCs-$H_2O_2$ system in the presence of various OPD concentrations, with the increase of OPD concentrations, the fluorescence emission peak around 565 nm attributed to OPDox enhanced accordingly.

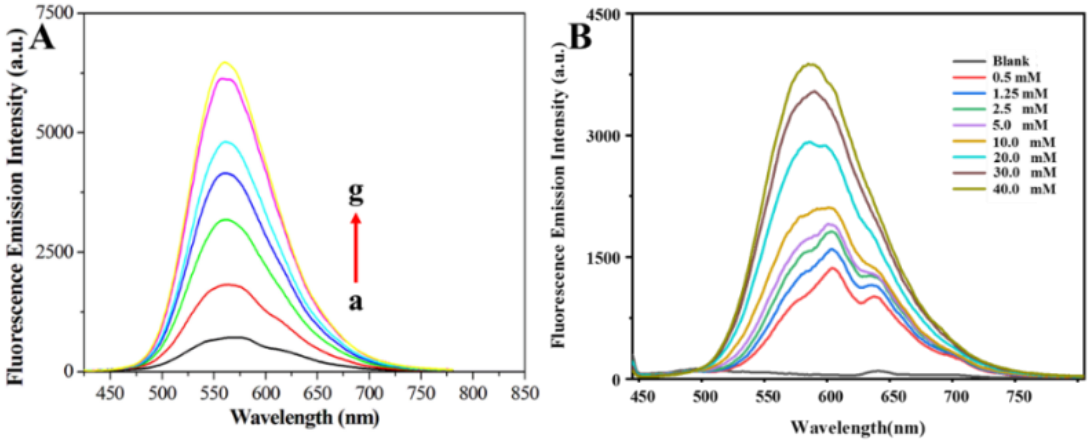


Figure 1 – Fluorescence emission

The fluorescent changes of Fe NCs and glucose oxidase system response to various glucose environments were shown in fig. 2, *a*. It can be seen that with the increase of glucose concentration, the fluorescence emission peak around 616 nm decreased gradually. As shown in fig. 2, *b*, the relationship between the logarithm of fluorescence intensity at 616 nm and glucose concentrations in the range of 0–100 μmol·$L^{-1}$ could be well described as the following equations: 10–$Lg(F_{616})$ = 0.00452[Glucose]+6.5849

The detection limit for glucose was 0.23 μmol·$L^{-1}$, and the fit coefficient was 0.994.

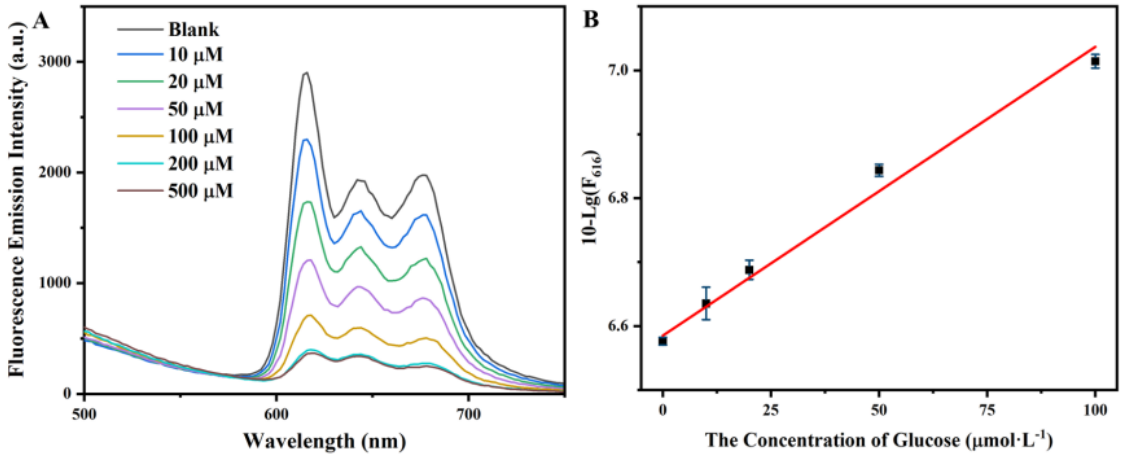


Figure 2 – Relationship between the logarithm of fluorescence intensity

We investigated the fluctuation of fluorescence intensity at 616 nm of Fe NCs, glucose oxidase, glucose system under different pH environments (fig. 3, *a*) and the fluorescent response of this system for series of biomolecules (fig. 3, *b*). In order to use the detection system with greater ease, we injected the Fe NCs and glucose oxidase solution into the cooling agarose gel. As shown in fig. 3, *c*, under UV light, the abtained agarose gel pieces changed from bright red to bluish violet after the addition of 2 mmol·$L^{-1}$ glucose solution for 1 hour.

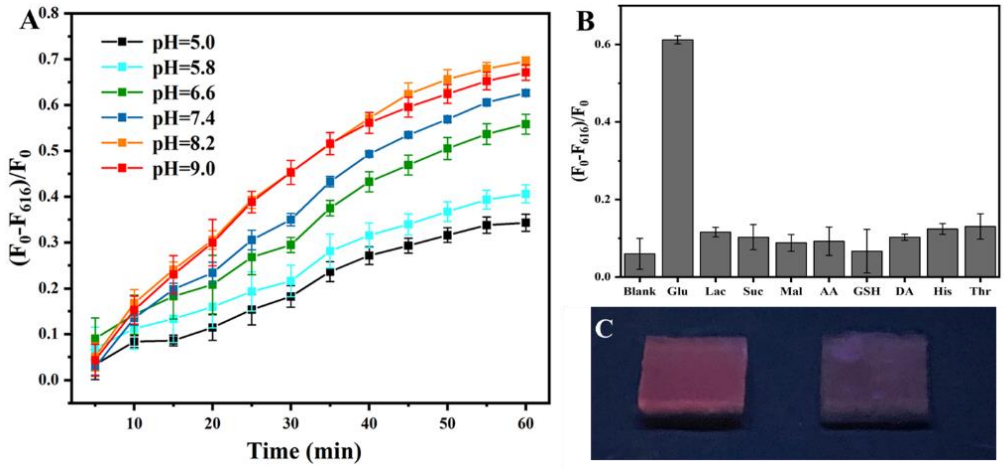


Figure 3 – Response of this system for series of biomolecules

We developed a fluorescent system for detection of glucose in the range of 0–100 μmol·$L^{-1}$ based on Fe NCs and glucose oxidase system. Importantly, the Fe NCs and glucose oxidase system was prepared into agarose gel pieces that can be conveniently used for visual detection of glucose, which has broad development prospects.