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Cellulose as a catalyst in water treatment

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INTRODUCTION & AIM

Cellulose-ZnO films represent a promising area of research due to their unique properties and potential applications in various fields, particularly in biomedical and environmental sectors. These films are typically created by integrating zinc oxide nanoparticles with cellulose, a natural biodegradable polymer derived from plant biomass [1]. Cellulose is a biocompatible and biodegradable polymer, ZnO is also generally considered biocompatible and non-toxic. This combination results in films show potential in photocatalytic applications, such as degrading pollutants [2]. ZnO is a well-known UV absorber, and its incorporation into cellulose films imparts excellent UV-blocking properties. This is beneficial for applications like the packaging to protect contents from UV radiation [3].

METHOD

Film preparation

0.1 g agar dissolved in 25 ml H2O at 90 °C, added 2 ml glycerol and 0.5 g soluble cellulose. In another hand, 0.5 g ZnO dissolved in 25 ml H2O. Mix 2 solutions and shaken for 1 h at 90 °C, then put the mix on petri dish to dried at room temperature for 24 h.

Photocatalytic method

Cut (2 mm, 8 mm) ZnO-cellulose sheet, put it in 100 ml of 5 mg/l crystal violet, the solution stirred in the dark for 30 min to establish the absorption of the film. Following this, 5 ml sample of the solution was taken every 15 min an analysed by UV-Visible spectroscopy at 590 nm.

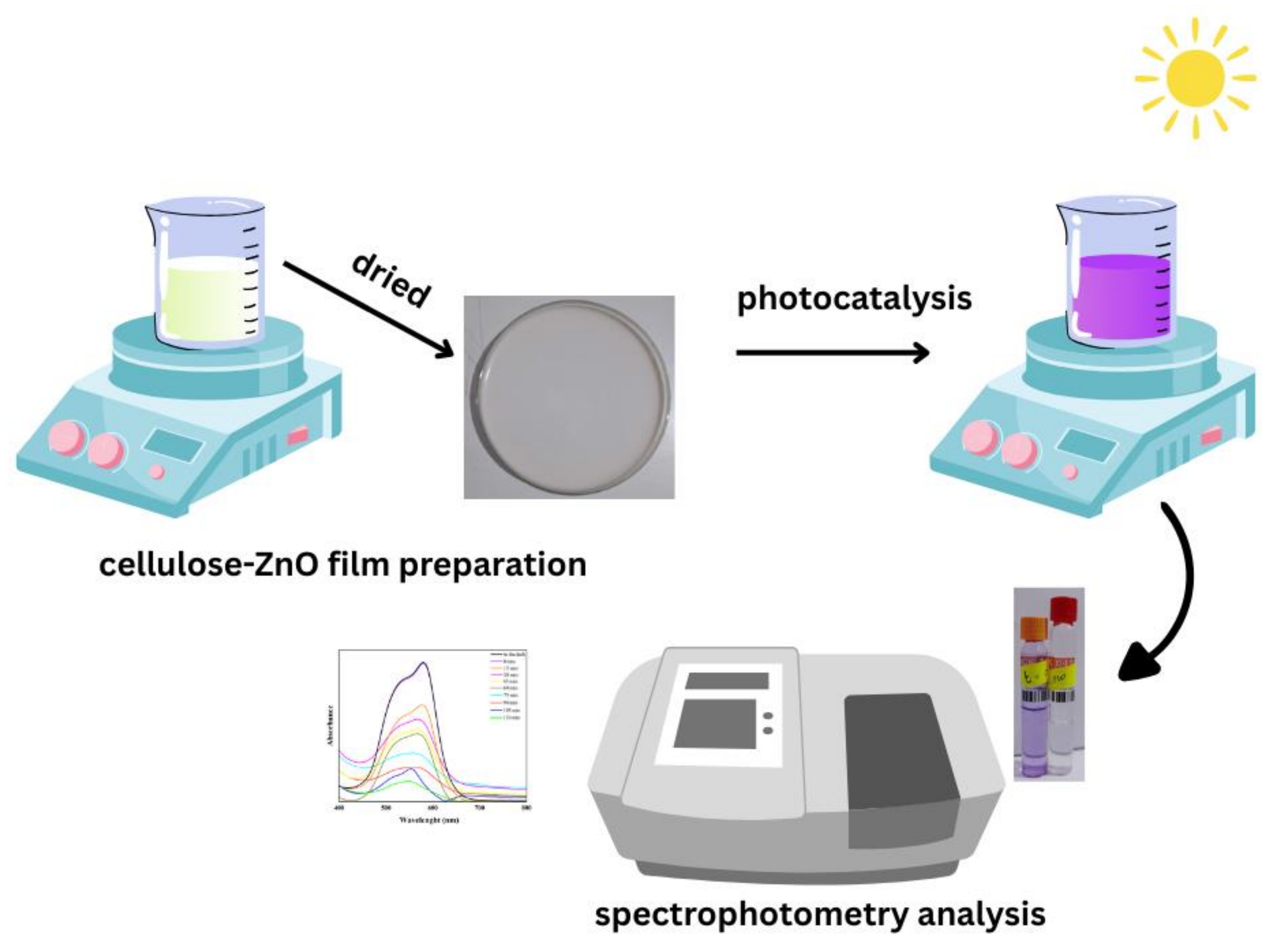

Figure 1: cellulose-ZnO film preparation and phtocatalysis method.

RESULTS & DISCUSSION

When the film is placed in a crystal violet solution, CV molecules adsorb onto the surface of the film.Cellulose plays a key role here, it's hydrophilic and has hydroxyl groups, helping trap CV molecules near ZnO nanoparticles, enhancing the degradation efficiency. As degradation proceeds, the absorbance at this wavelength decreases, indicating dye breakdown (Figure 2).
Under UV light, the electron (e^-) can reduce oxygen ($O_2 \rightarrow O_2^-\bullet$), and the hole ($h^+$) can oxidize water or OH^- ($\rightarrow OH\bullet$). These reactive oxygen species like hydroxyl radicals ($\bullet OH$) and superoxide ($O_2^-\bullet$) can degrade organic pollutants.

$$\mathbf{ZnO + h\nu \rightarrow e^- + h^+}$$

The Cellulose acts as a biodegradable support, improves film formation and mechanical strength, prevents agglomeration of ZnO nanoparticles, preserving surface area, and can enhance adsorption of pollutants before degradation.

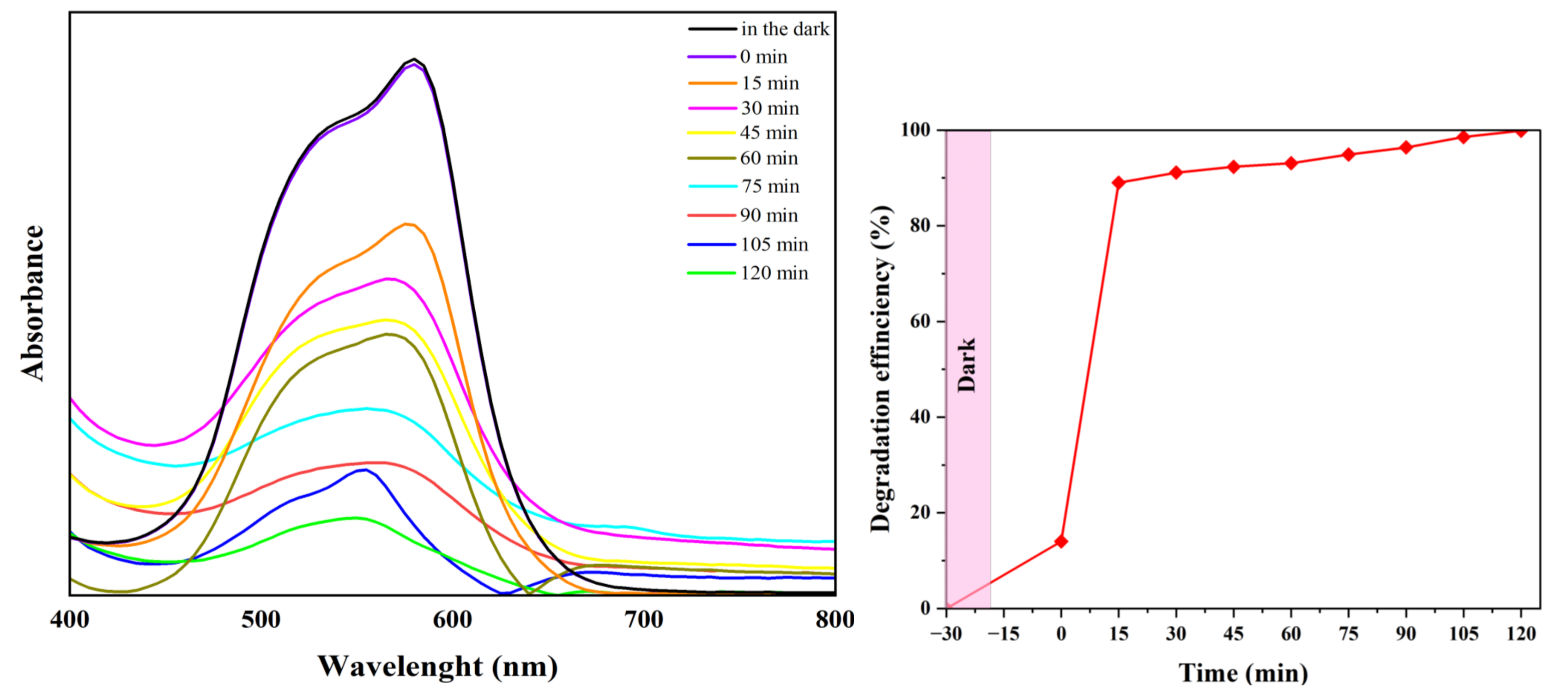

Figure 2: **a**-spectrophotometry analysis and **b-** degradation efficiency of crystal violet degradation.

CONCLUSION

An environmentally friendly cellulose-ZnO film has been successfully fabricated via a simple. The photocatalytic activity of the sample was demonstrated through the excellent degradation of organic dye that successfully removed crystal violet (≈99.85%). The cellulose-ZnO produced was capable of removing crystal violet dye with economy and eco-friendly films.

FUTURE WORK / REFERENCES

[1]: X. Li, X. Zhou, Y. Gao, L. Li, and J. Ye, "ZnO nanosheet regenerated cellulose film composite material and preparation method thereof," Nov. 27, 2018
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[3]: Mun, S., Kim, H. C., Ko, H. U., Zhai, L., Kim, J. W., & Kim, J. (2017). Flexible cellulose and ZnO hybrid nanocomposite and its UV sensing characteristics. Science and Technology of Advanced Materials, 18(1), 437–446. https://doi.org/10.1080/14686996.2017.1336642