

Controlled Deposition of Photothermally Active Ag@TiO₂ Coreshell onto Nano-cellulose Hydrogels Matrix for the Application of Diabetic Ulcer Therapy

Introduction

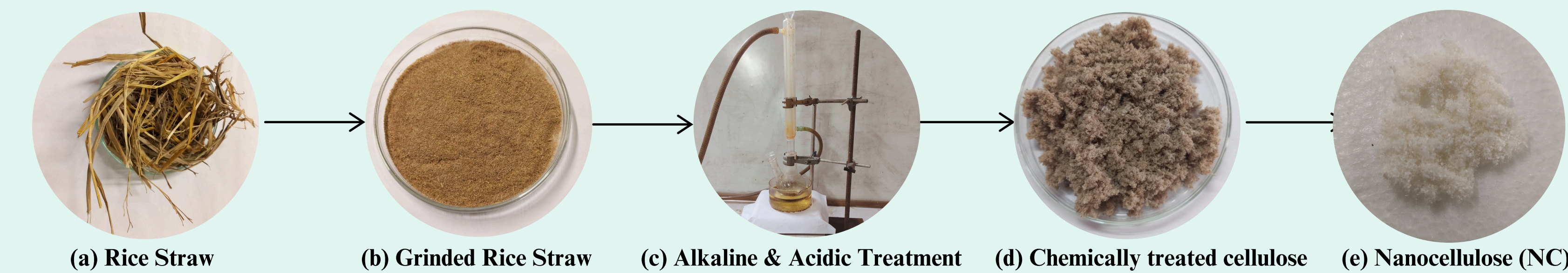
Diabetic ulcers are among the most critical complications of diabetes, characterized by delayed healing, impaired angiogenesis, and high susceptibility to infection. Conventional treatments often fail due to poor local circulation and microbial resistance. Hence, advance wound dressings that can simultaneously promote tissue regeneration and prevent infection are urgently needed.

Nanocellulose-based hydrogels are promising scaffolds due to their biocompatibility, tunable porosity, high water retention, and mechanical flexibility. Incorporating Ag@TiO₂ coreshell nano structures provides a synergistic therapeutic effect. The Ag core generates localized photothermal heat under near-infrared light, while TiO₂ contributes to reactive oxygen species (ROS) production, enabling antibacterial activity and accelerated wound closure. The work aligns with SDG 3

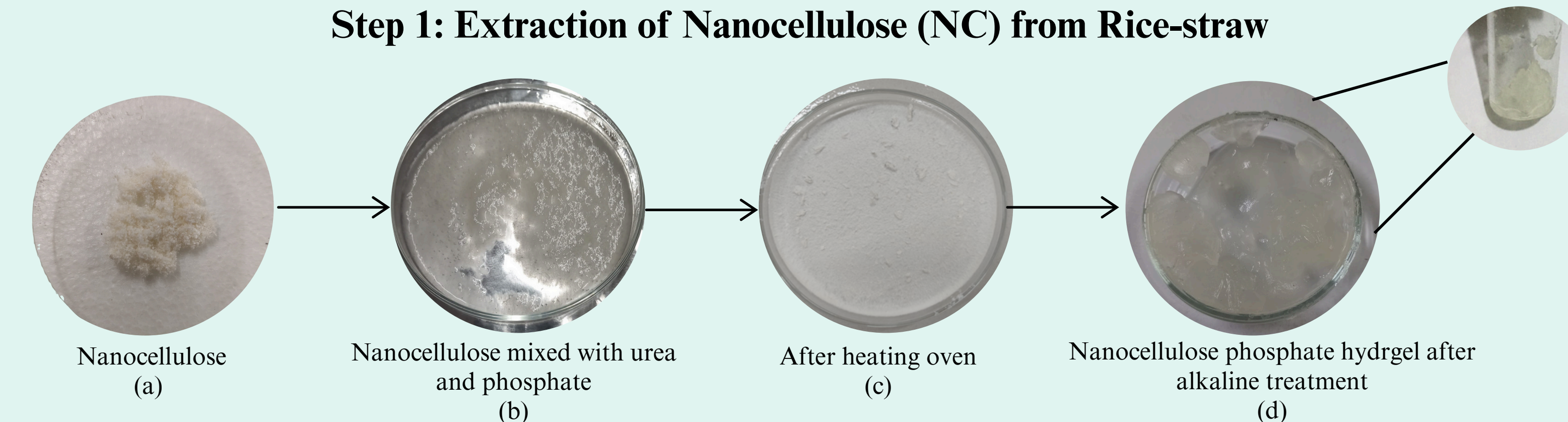
Objective

- To design a low cost hydrogel patch from nanocellulose and reinforce with Ag@TiO₂ for diabetic ulcer therapy.
- To achieve controlled deposition of ag@ within the hydrogel, ensuring stability, flexibility, and uniform distribution.
- To evaluate the antibacterial efficacy, photo-thermal performance, ROS generation and wound closure analysis in diabetic model

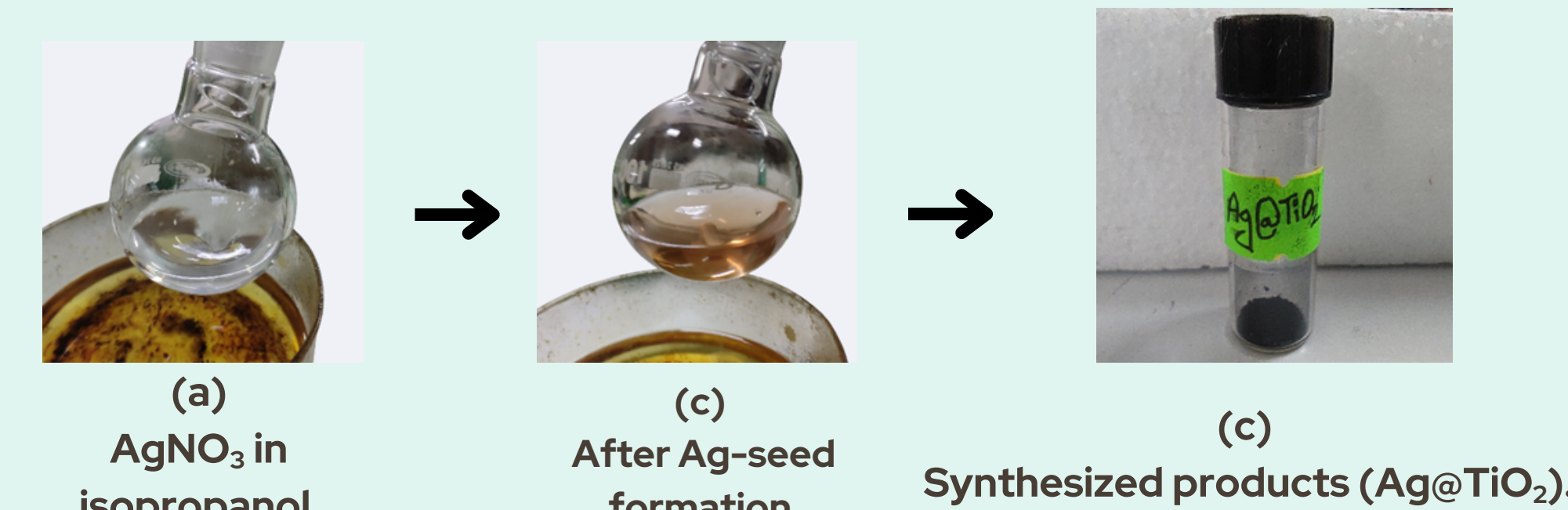
Methodology



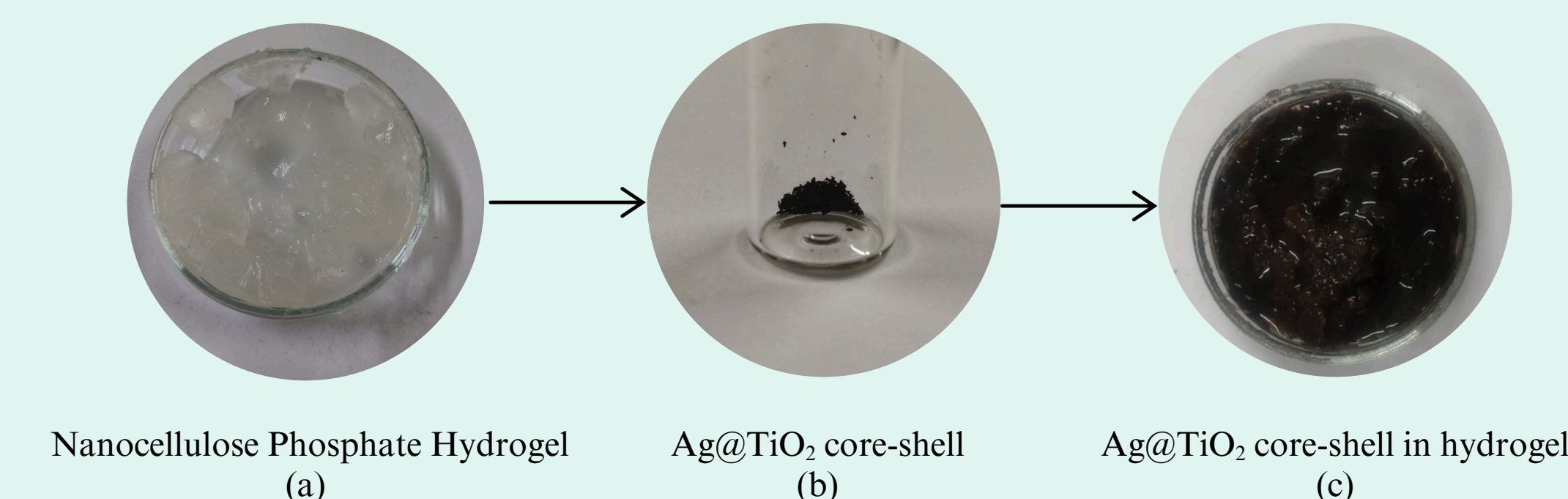
Step 1: Extraction of Nanocellulose (NC) from Rice-straw



Step 2: Preparation of Nanocellulose Phospahte Hydrogel



Step 3: Synthesis and Acid etching of Ag@TiO₂ core-shell



Step 2: Incorporating Ag@TiO₂ in Nanocellulose Phospahte Hydrogel

Reference

- [1]Mahabubur Rahman, Md Al-Amin, Amandeep Kaur, Shirin Akter Jahan, Andrew J. Wilson, Nur Uddin Ahamad, Optimizing the Shell Thickness of Ag@TiO₂ Nanostructures by a Simple Top-Down Method to Engineer Effective SERS Substrates and Photocatalysts, ACS Omega 2025, Article ASAP, 10.1021/acsomega.4c1027
- [2] Guozhi Fan, Min Wang, Chongjing Liao, et al. Isolation of cellulose from rice straw and its conversion into cellulose acetate catalyzed by phosphotungstic acid. Carbohydrate Polymers, 2013, 94, 71–76.6

Result

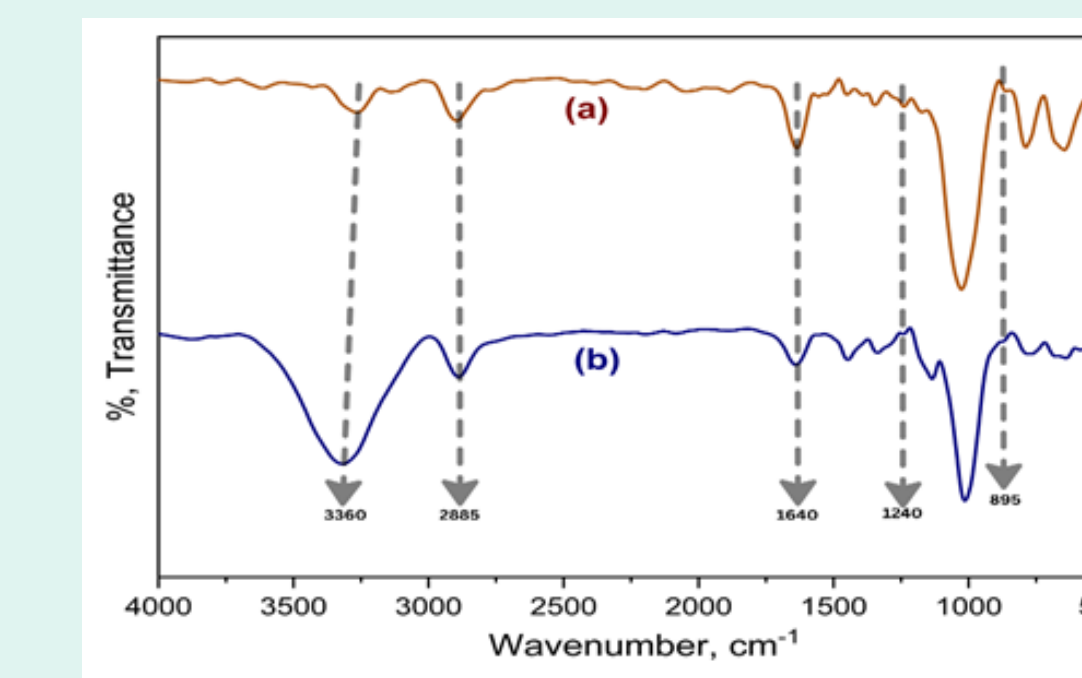


Figure 1: FTIR spectrum of (a) rice straw (b) cellulose.

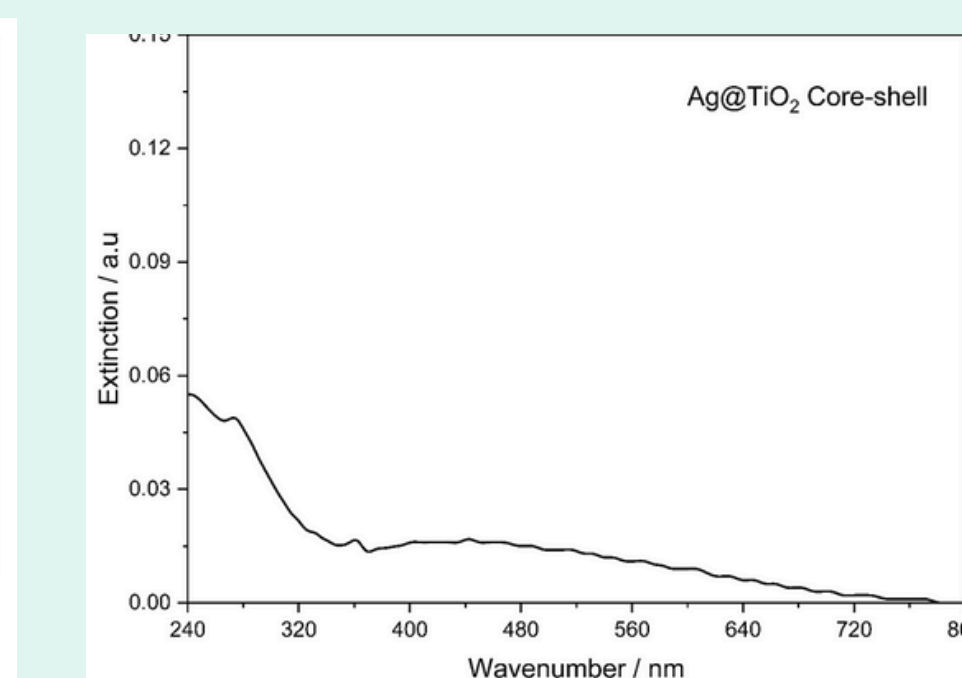


Figure 2: UV-Vis spectra analysis of Ag@TiO₂ core-shell

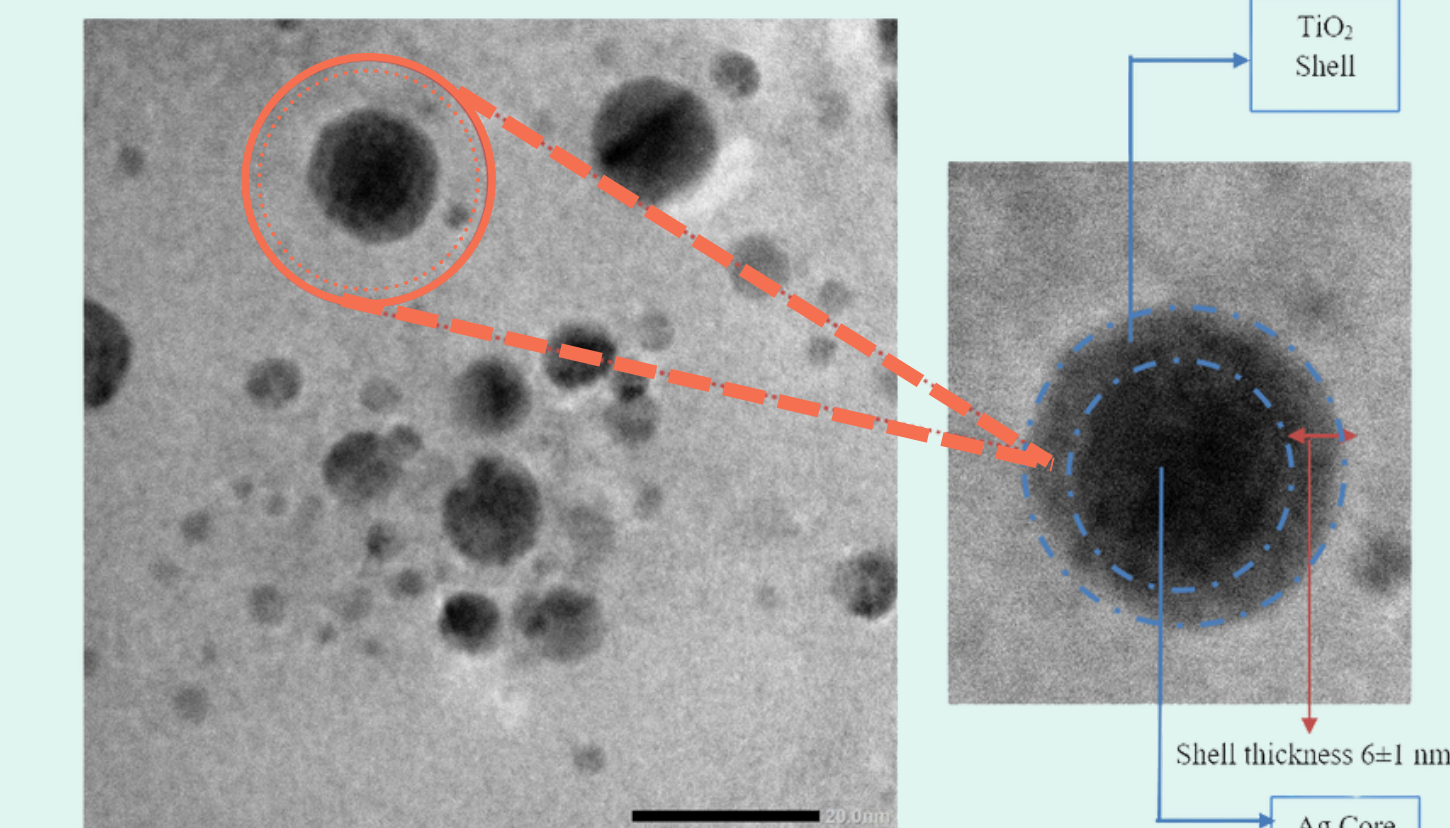


Figure 3: Transmission electron microscopy (TEM) image of Ag@TiO₂

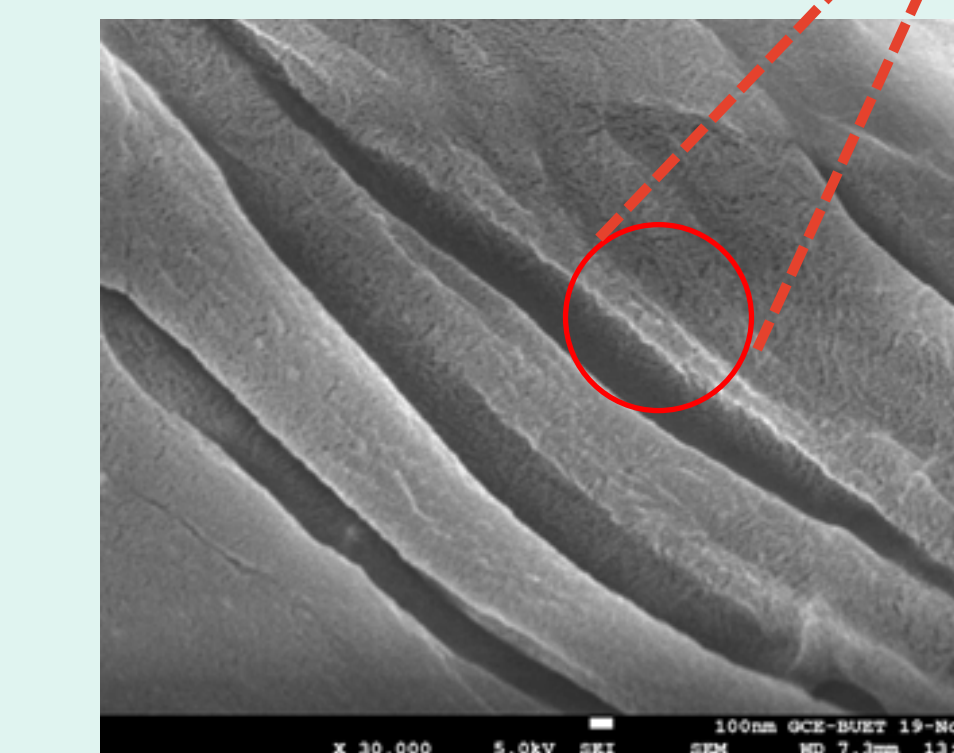


Figure 4: SEM Image of Cellulose

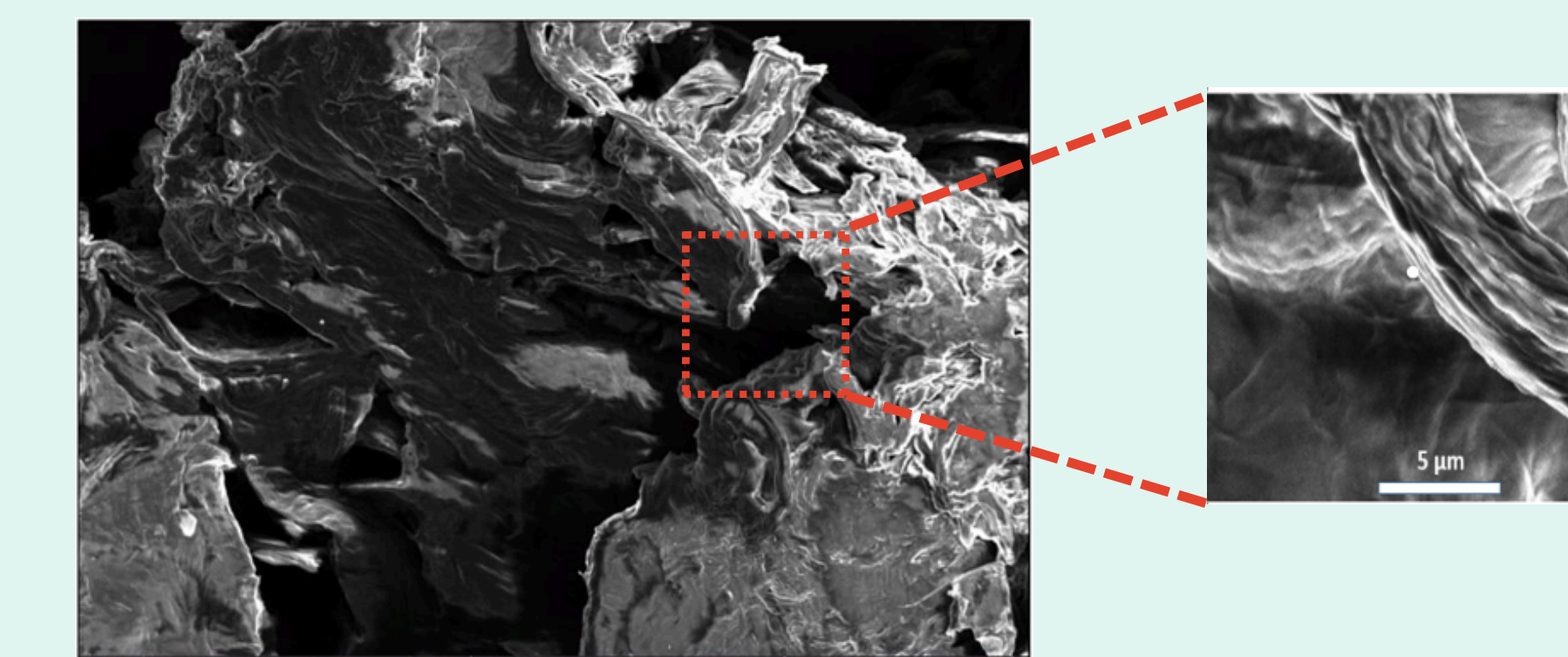


Figure 5: SEM Image of nanocellulose phosphate at two magnifications

Conclusion and Future Direction

Nanocellulose was successfully extracted from rice straw and hydrogel was prepared effectively . SEM images of nanocellulose revealed the characteristic fibrous structure of cellulose, whereas nanocellulose phosphate hysrogl exhibited a more open, rough, and porous structure due to chemical modification. Ag@TiO₂ were synthesized and deposited into the hydrogel .In future, our research will focus on-

- Spectroscopic and microscopic characterization will be performed to validate the successful incorporation of Ag@TiO₂ nanostructures within the nanocellulose hydrogel matrix.
- Conducting antibacterial test and cytocompatibility assays, diabetic wound healing models to track closure, microbial load and tissue regeneration.