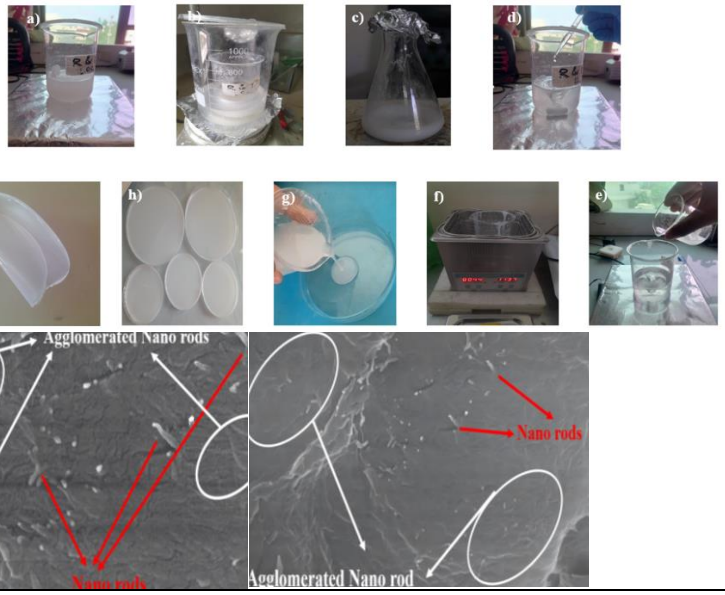
Final Year Project Showcase
Batch-2022
Year 2026

	Department: Materials Engineering Programme: BE Materials Engineering
1	**Project Idea** This project aims to convert waste paper into value-added nanocellulose and utilize it to develop biodegradable composite films for sustainable packaging applications. Waste paper is used as a renewable cellulose source, reducing waste sent to landfills while producing a functional nanomaterial. Nanocellulose is extracted using ammonium persulfate (APS) oxidation and incorporated into a polyvinyl alcohol (PVA) matrix. Glycerol is used as a plasticizer to improve flexibility, while stearic acid is used as a surface-modifying agent to improve water resistance. The project goal is "Development of Nanocellulose from Paper Waste for Biodegradable Applications".
2	**Process** Waste paper is collected, cleaned, shredded and soaked before chemical treatment. Nanocellulose is extracted using an aqueous ammonium persulfate (APS) oxidation process under controlled heating, followed by washing and filtration/drying to obtain the nanocellulose. The extracted nanocellulose is characterized using XRD, SEM/EDS, FTIR and thermal analysis. For film fabrication, PVA is prepared in water and the nanocellulose is dispersed into the polymer matrix. A portion of nanocellulose is surface-modified with stearic acid. Glycerol is then added as a plasticizer, followed by degassing and solution casting. The films are dried and evaluated through structural, thermal, mechanical, optical, surface-wettability and biodegradation tests.
3	**Outcome** The project successfully demonstrated the conversion of waste paper into nanocellulose and its use in biodegradable PVA-based composite films. XRD, SEM and FTIR results supported the successful formation and incorporation of nanocellulose. Addition of nanocellulose improved the strength and flexibility of the PVA-based film compared with pure PVA. Stearic-acid modification increased the water contact angle, indicating improved hydrophobicity, although the modified film showed lower tensile strength than the unmodified PVA/NCC/GLY film. TGA/DSC, UV-Vis, contact-angle, tensile and soil-burial testing demonstrated the potential of the developed films as biodegradable alternatives for selected packaging applications.
4	**Evidence (Theoretical Basis):** Nanocellulose was extracted from waste paper using APS oxidation and incorporated into a PVA matrix to prepare biodegradable packaging films. XRD showed crystallite sizes ranging from 2–60 **nm,** while SEM showed rod-like nanostructures with lengths of **1–100 nm** and diameters of **18–21 nm.** The PVA/NCC/GLY film showed a water contact angle of **39°,** which increased to **75.9°** after stearic acid modification, indicating improved water resistance. Soil burial testing showed initial degradation after **7 days,** with significant degradation after **15–20 days**. These results show that waste-paper-derived nanocellulose can be used to prepare biodegradable packaging films with improved water resistance.
5	**Competitive Advantage or Unique Selling Proposition:**

a	**Attainment of any SDG; SDGs-09** This project supports innovation by converting waste paper into nanocellulose and using it to make biodegradable packaging films. **SDGs-12** This project promotes responsible production by using waste paper as a raw material and developing a biodegradable alternative to plastic packaging. **SDGs-13** This project helps reduce waste by developing packaging films from waste paper and biodegradable materials.	
b	**Any Environmental Aspect:** Waste paper utilization, biodegradable material, reduced plastic waste, sustainable material processing, and eco-friendly packaging.	
c	**Cost Reduction of Existing Product:** Waste paper is an inexpensive and readily available feedstock compared with virgin cellulose sources, creating potential for lower raw-material costs while simultaneously recovering value from waste. The laboratory-scale process also uses solution processing and commonly available materials for film fabrication. A detailed industrial cost analysis was outside the scope of the project, so commercial cost savings have not been quantified.	
d	**Process Improvement which Leads to Superior Product or Cost Reduction, Efficiency Improvement of the Whole Process:** The process integrates waste-paper valorization, APS-based nanocellulose extraction and biodegradable composite-film fabrication in a single material-development route. The APS route provides bleaching and oxidation, while nanocellulose reinforcement and stearic-acid surface modification address mechanical and moisture related requirements within the same film system. Further optimization of stearic-acid content and nanocellulose dispersion is recommended to better balance strength and water resistance.	
e	**Expanding of Market share:** The global nanocellulose market is valued at approximately USD 0.76 billion**,** while the biodegradable packaging market is valued at approximately USD 117.74 billion**,** with growing demand for sustainable materials and alternatives to conventional plastic packaging. However, the cost of raw materials and processing can limit the wider use of nanocellulose-based products. This project uses low-cost waste paper as a source of nanocellulose and combines it with PVA to develop biodegradable packaging films. Further improvement in film strength, water resistance, and production methods can reduce costs and improve performance. This can create opportunities in sustainable packaging and increase the use of waste-derived nanocellulose materials.	
f	**Capture New Market:** Potential new application areas include sustainable food and non-food packaging, biodegradable film products, paper and packaging manufacturers, environmentally responsible consumer-goods packaging, and other applications where biodegradable composite films are required.	
6	**Target Market:** The target market includes packaging manufacturers, food and non-food packaging suppliers, paper-based product manufacturers, and organizations seeking biodegradable alternatives to conventional plastic packaging. The material may also be relevant to research and development sectors focused on waste valorization and sustainable polymer composites.	
7	**Team Members** (Names along with email address)	Alina Batool (batool4500033@cloud.neduet.edu.pk) Syed Faseeh Haider(zaidi4502735@cloud.neduet.edu.pk)
8	**Supervisor Name** (along with email address)	Dr. Sajid Ali Asghar (Associate Professor NEDUET), smsajid@cloud.neduet.edu.pk Engr. Umer Hussain (MMD Engineer,SSGC)

10	**Pictures (If any)**