Wearable Perspiration Profiling System (PPS)

Mid-Review 1/2/3

GITAM
DEEMED TO BE UNIVERSITY

AY 2021-25

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Major Project
Project ID: V6

Project Team:
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Department of Electrical Electronics and Communication Engineering

Project Mentor:
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Project In-charge:
- Pankaj Kandhway

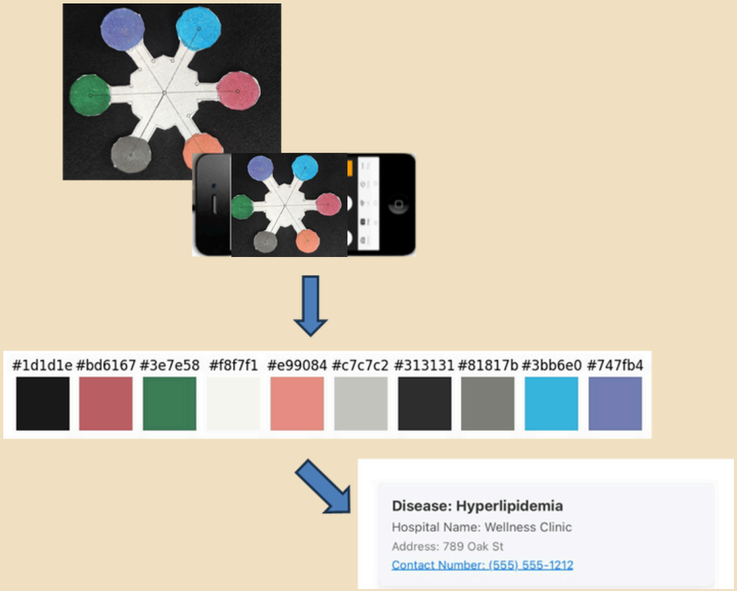
Objective and Goals

Objective

•To develop a scalable, non-invasive, and cost-effective diagnostic platform for Alzheimer's disease (AD).
•To Develop a sweat-based biomarker detection patch integrated with colorimetry and a mobile application.

Expected Out Come

- GQD Synthesis and Characterization Achieved
- Optimized Sensitivity for Biomarker Detection
- Integrated GQDs into Nano-Patch
- Validated Colorimetric Response for Diagnostics
- Developed Mobile Application for Data Analysis



Project Plan

Project Title: Wearable Perspiration Profiling System (PPS)																
Tasks	TIMELINE															
	PHASE I								PHASE II							
	Aug-24		Sep-24		Oct-24		Nov-24		Dec-24		Jan-25		Feb-25		Mar-25	
Project Selection																
Identification of the Problem																
Literature Review																
Material Research																
Material Selection																
GQD (Graphene Quantum Dots) Synthesis																
GQD Characterization (UV-Vis, XRD, FTIR)																
Design Nano-patch (Concept & Structure)																
Development of Dip Coating Method																
Testing of Materials (e.g., Oxide)																
Fabricate Initial Nano-patch Prototype																
Coating Nano-patch with GQDs																
Initial Prototype Testing (Performance)																
Testing with Different Coatings & Combinations																
Performance Evaluation (Prototype)																
Optimize Coating Process & Prototype																
Data Collection from First Trials																
Documentation																
Milestone(In percentage)		5%	10%	15%	20%		35%	55%		90%						100%

Literature Survey

S.No	TITLE	AUTHORS	PUBLISHED YEAR	ABSTRACT
1	Alzheimer Disease	Anil Kumar, Jaskirat Sidhu, Forshing Lui, Jack W. Tsao	February 12, 2024	Alzheimer's disease starts with memory loss and worsens to severe cognitive and behavioral issues, requiring increasing care. Quality of life declines significantly, and effective management remains uncertain, needing further research.
2	Recent Developments in Alzheimer's disease therapeutics	Michael S Raafii,Paul S Aisen	February 19,2009	Anti-amyloid strategies dominate Alzheimer's research, with numerous disease-modifying therapies in trials. Success is uncertain, but a future combination of agents may alter neurodegeneration and reduce the disease's global impact.

Literature Survey

S.No	TITLE	AUTHORS	PUBLISHED YEAR	ABSTRACT
3	Recent Advances in Wearable Sensors for the Monitoring of Sweat: A Comprehensive Tendency Summary	Zhe Xing,Jianan Hui,Bo Lin,Zhenhua Wu,Hongju Mao	23 August,2023	Wearable sweat sensors offer real-time, non-invasive monitoring. Recent advances span biomarkers, materials, and system designs, focusing on integrated sensors for practical applications, with future innovations expected in physiological signal detection.
4	Neurology	Bryan D.James,Sue E.Leurgans,Liesi E.Hebert,Paul A.Scherr,Kristine Yaffe,David A.Bennett	25 March,2014	In an 8-year study, 21.8% developed Alzheimer's dementia, with an average diagnosis age of 86.5. Median survival was 3.8 years, with 72% of those diagnosed eventually dying.

Literature Survey

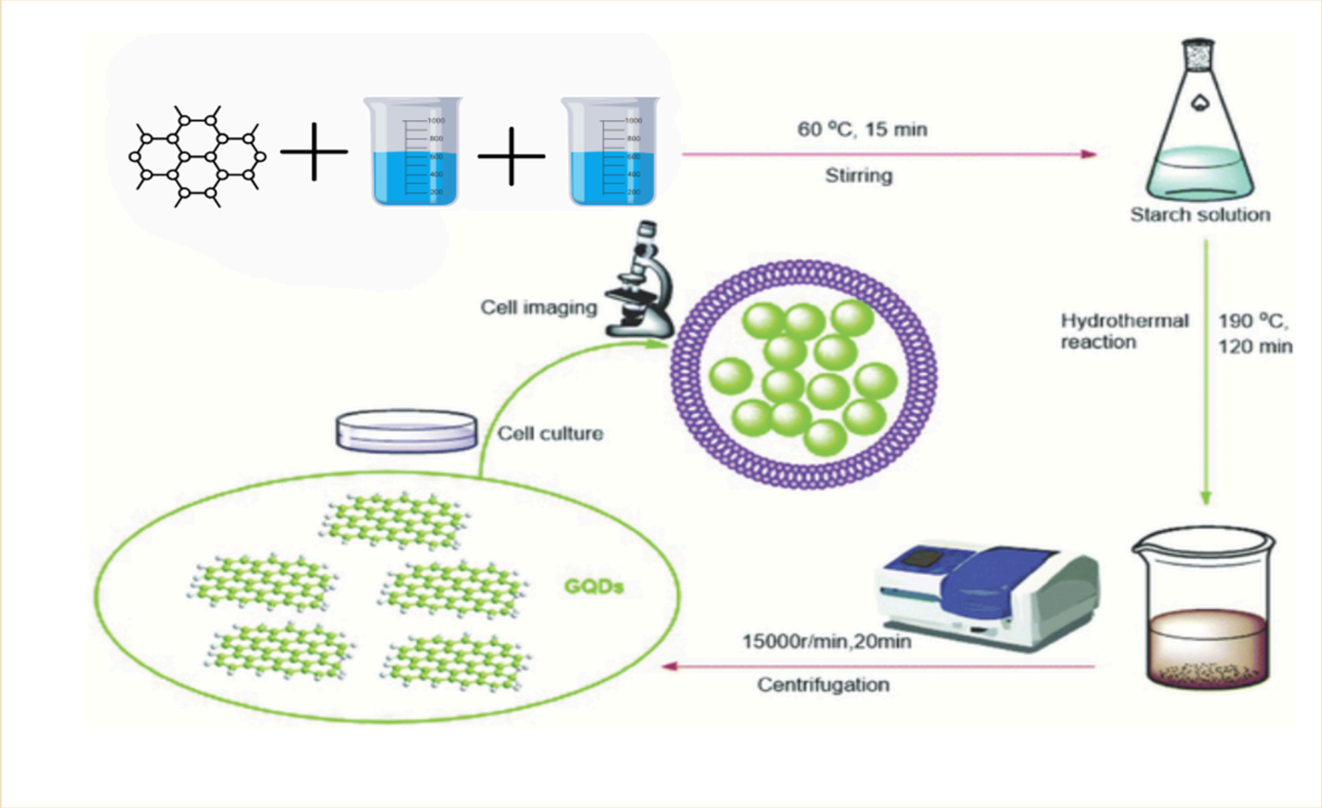
S.No	TITLE	AUTHORS	PUBLISHED YEAR	ABSTRACT
5	A wearable patch for continuous analysis of thermoregulatory sweat at rest	Hnin Yin Yin Nyein,Mallika Bariya,Brandon Tran,Christine Heera Ahn,Brenden Janatpour Brown,Wenbo Ji,Noelle Davis,Ali Javey	23 March,2021	The wearable device analyzes sweat in real-time, linking sweat rates to physiological conditions like hypoglycemia and stress, offering non-invasive monitoring and new insights into health through sweat analysis.
6	A review of Wearable biosensors for sweat analysis	Seongbin Jo,Daeun Sung,Sungbong Kim,Jahyun Koo	07 May,2021	Recent research on wearable sensors focuses on advanced devices for real-time monitoring, using skin-interfaced microfluidics and integrated electronics for accurate health data collection and analysis in various applications.

Literature Survey

S.No	TITLE	AUTHORS	PUBLISHED YEAR	ABSTRACT
7	Recent Developments in Sweat Analysis and Its Applications	Int J Anal Chem	09 March,2015	Sweat analysis, combined with genomics and proteomics, reveals biomarkers for diseases like cancer and diabetes. This makes sweat a promising biofluid for diagnosing illnesses and exploring new treatments.
8	A Simple Approach to Stepwise Synthesis of Graphene Oxide Nanomaterial	Paulchamy Arthi Lignesh B Durai	01 January 2015	Technology research in nanotechnology promises breakthroughs in areas such as materials and manufacturing, nanoelectronics, medicine and healthcare, energy, biotechnology, information technology, and national security. One of the crucial bottlenecks for the application of graphene-based systems in materials science is their mass production. Meeting the requirements, graphene oxide (GO) has been considered widely as a prominent precursor and a starting material for the synthesis of this processable material. This work describes the synthesis of Graphene oxide (GO) by both Hummer's and Modified Hummer's method and its characterization by XRD, FT-IR spectroscopy and SEM. The results obtained from the characterization techniques mentioned above is also explained. This GO acts as a base material for the future application of water purification, super capacitors and as a composite in antibacterial activity, solar cells and coatings.

Architecture

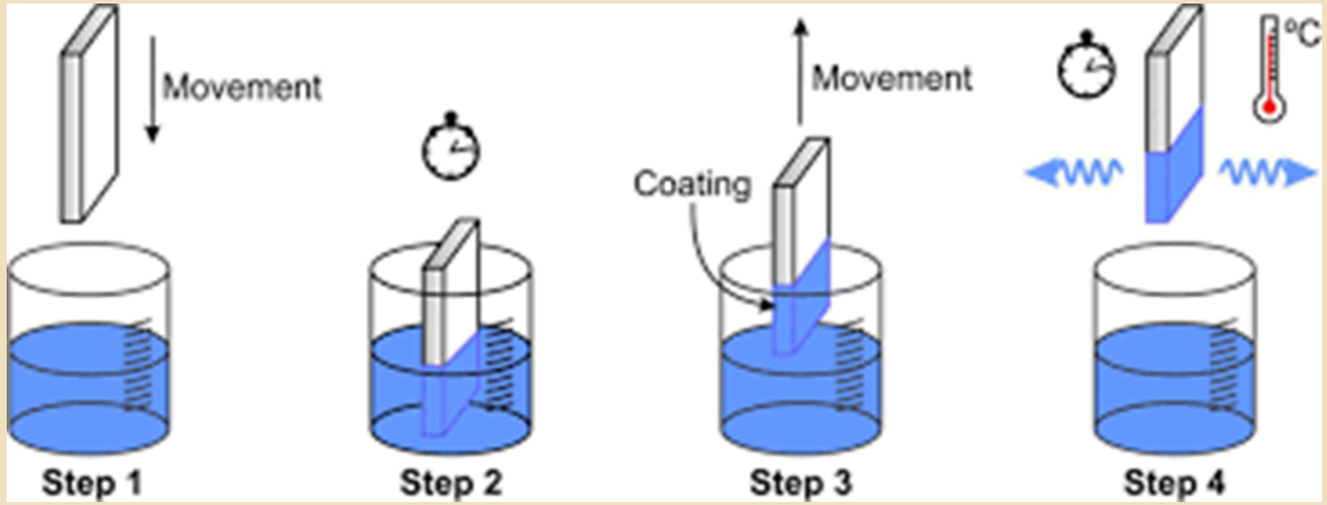
Synthesis Process of GQDs



1. Carbon fibers are treated with the acid mixture for initial breakdown.
2. Graphene fragments formed through chemical oxidation.
3. Ultrasonic waves are applied to enhance disintegration.
4. Heating is applied at different temperatures to control properties.
5. Adjusted pH and diluted to stabilize the solution.
6. Impurities are removed through dialysis over several days.
7. High-purity GQDs prepared for use

Architecture

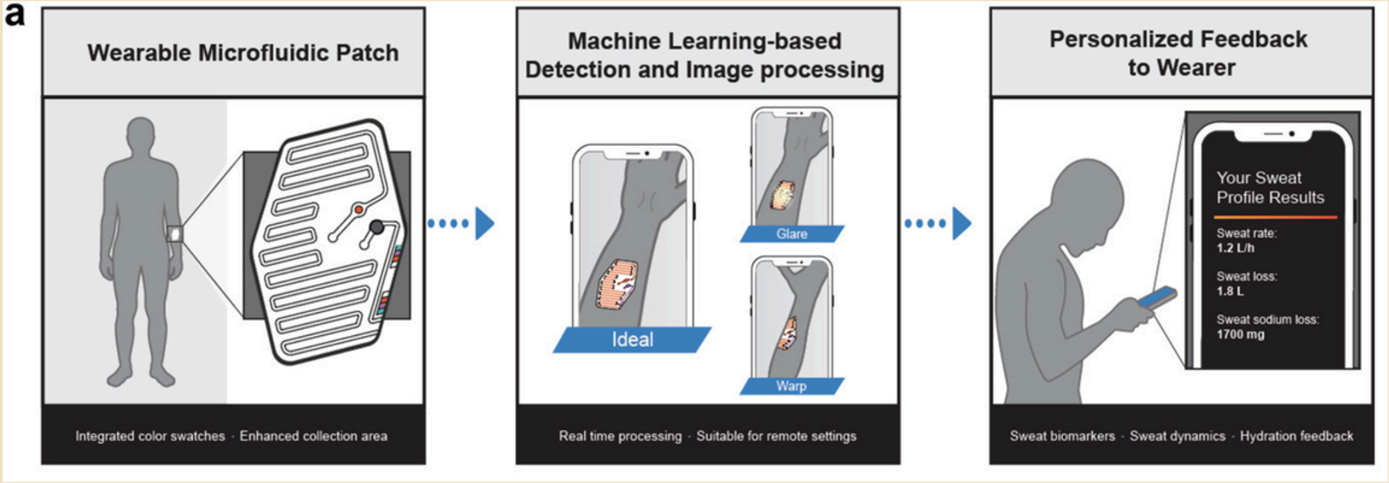
Fabricating GQD-Enhanced Biomarker Detection Patches



- You can select a paper substrate for GQDs.
- Clean the paper to improve adhesion.
- Prepare a GQD dispersion in water.
- Dip the paper into the GQD solution.
- Air dry the coated patch completely.
- Functionalize the patch for sweat biomarkers.
- Inspect the patch for uniformity and adherence.

Architecture

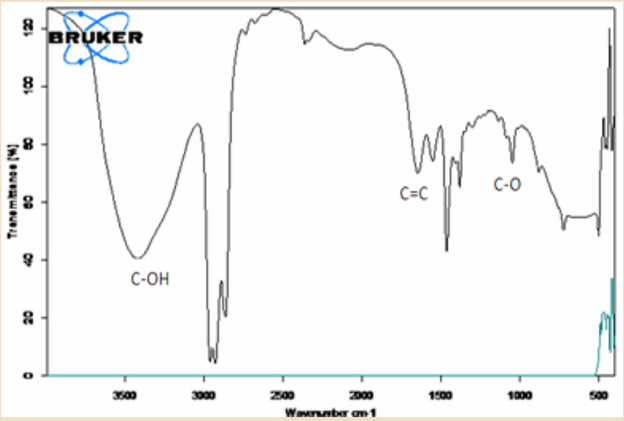
Colorimetric Detection& Mobile Application



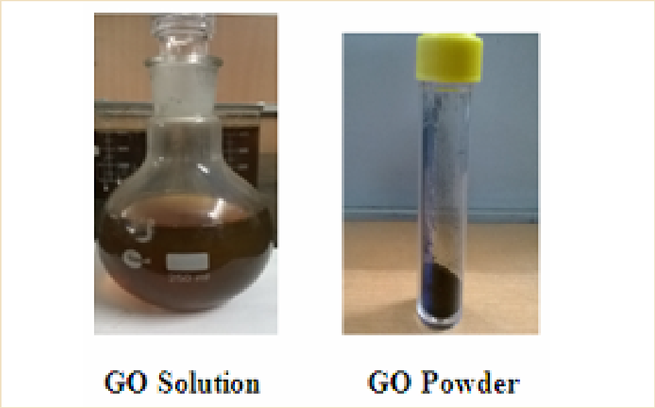
1. Sweat biomarkers cause GQD color changes.
2. Color shifts indicate biomarker presence.
3. Optical sensors effectively detect these changes.
4. Smartphone cameras capture color transformations.
5. The app processes colorimetric data.
6. It delivers real-time biomarker feedback.
7. Users gain insights for informed health decisions.

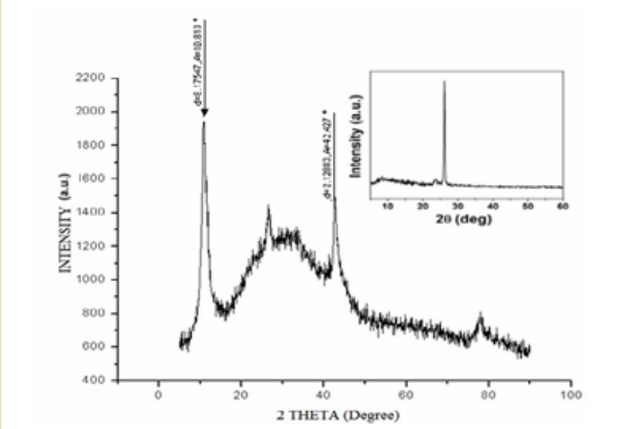
Implementation and Results – Iteration 1

Iteration 1 : GQD Graphs & Paste

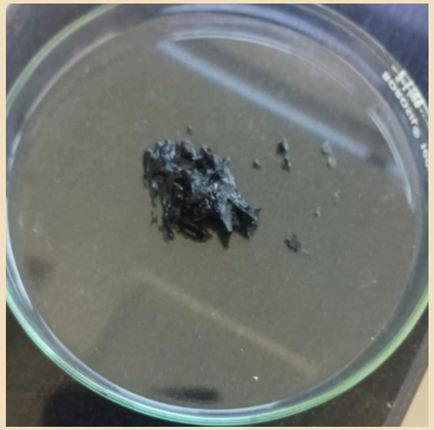


FTIR





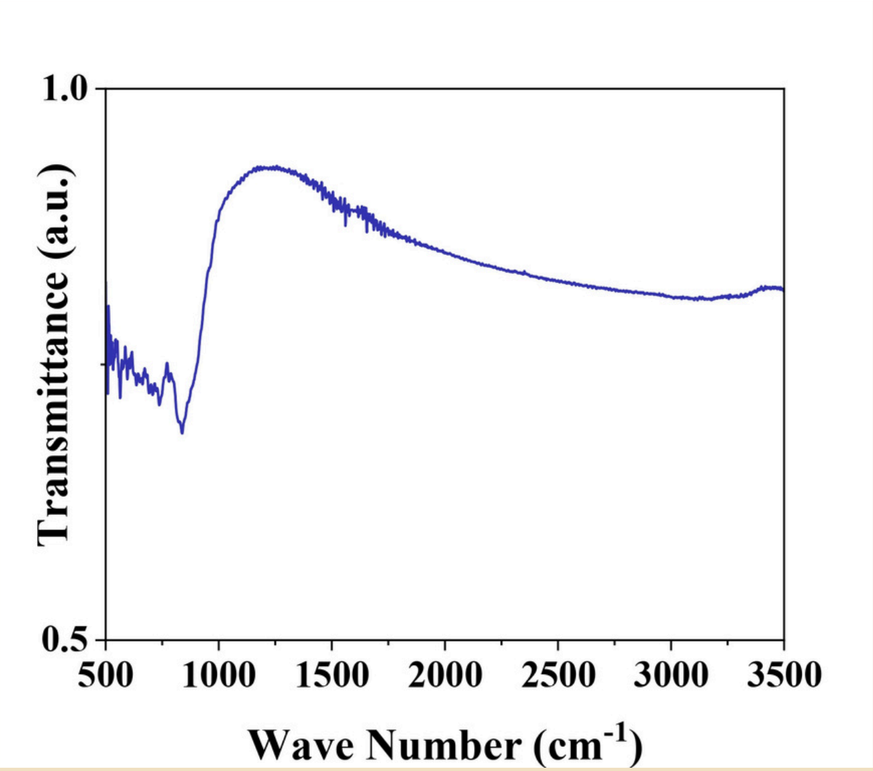
XRD Graph



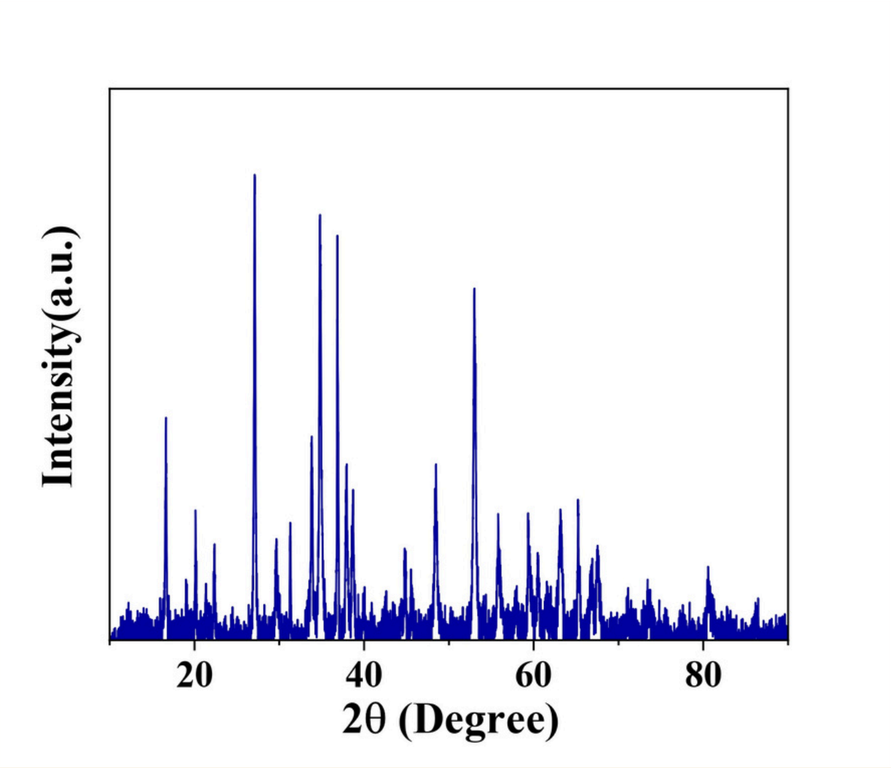
Quatum Dot Paste

Implementation and Results – Iteration 2

Iteration : NiAlO2 Oxide Results



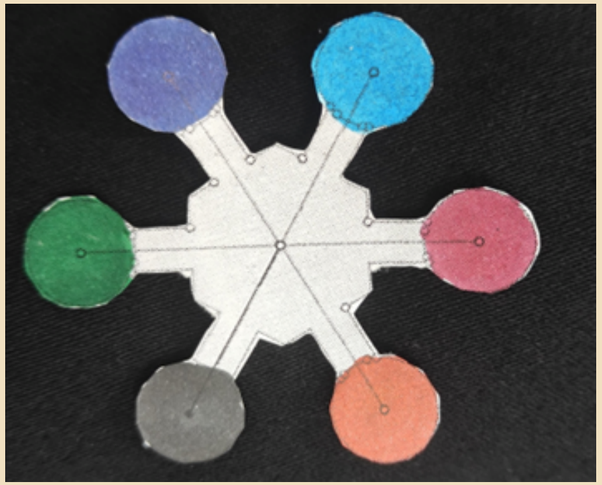
XRD Graph



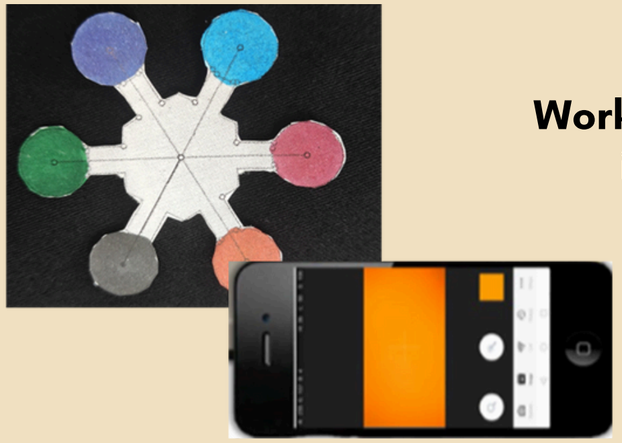
FTIR

Implementation and Results – Iteration 2

Iteration : Patch Design



Patch Design



Working of Moblie Application integrated with patch

Contribution

Team Progress and Movement

- Initial Planning and Research
- Design Phase
- Synthesis and Coating of GQDs
- Testing and Validation
- Mobile Application Development

Individual Contribution

Key contributions: Poojitha Reddy
- Synthesized GQDs, optimizing oxidation for quality.
- Developed uniform coating methodology for substrates.

Key contributions: Poorna Chandra
- Managed data collection and organization phases.
- Collaborated on the final presentation preparation.

Conclusion & Future Work

Summary and Conclusion

- Successfully synthesized Graphene Quantum Dots (GQD) and oxide for sweat sensing.
- Developed an app to interface with the wearable sensor.
- Laid the groundwork for a real-time perspiration profiling system.

Future Work

- Solution Development: Refining sensor integration for real-time sweat analysis.
- Startup Launch: Moving from prototype to commercialization, targeting sports, healthcare, and defense markets.
- Product Optimization: Enhancing sensitivity, miniaturization, and real-world validation.
- Scaling Up: Manufacturing and regulatory approvals for commercialization.
- AI Integration: Developing predictive models for hydration and electrolyte balance using sensor data.

THANK YOU

Have a Great Day !