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Adaptive SWCNT–Liquid Crystal Hybrids for Neuromorphic and Low-Power Photonic Devices

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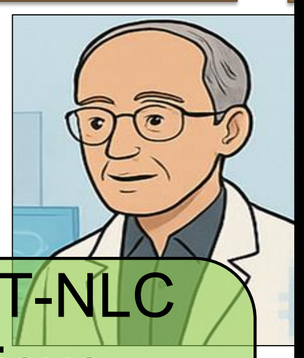
INTRODUCTION & AIM

Professor, Photonic materials still consume a lot power and switch slowly, don't they?

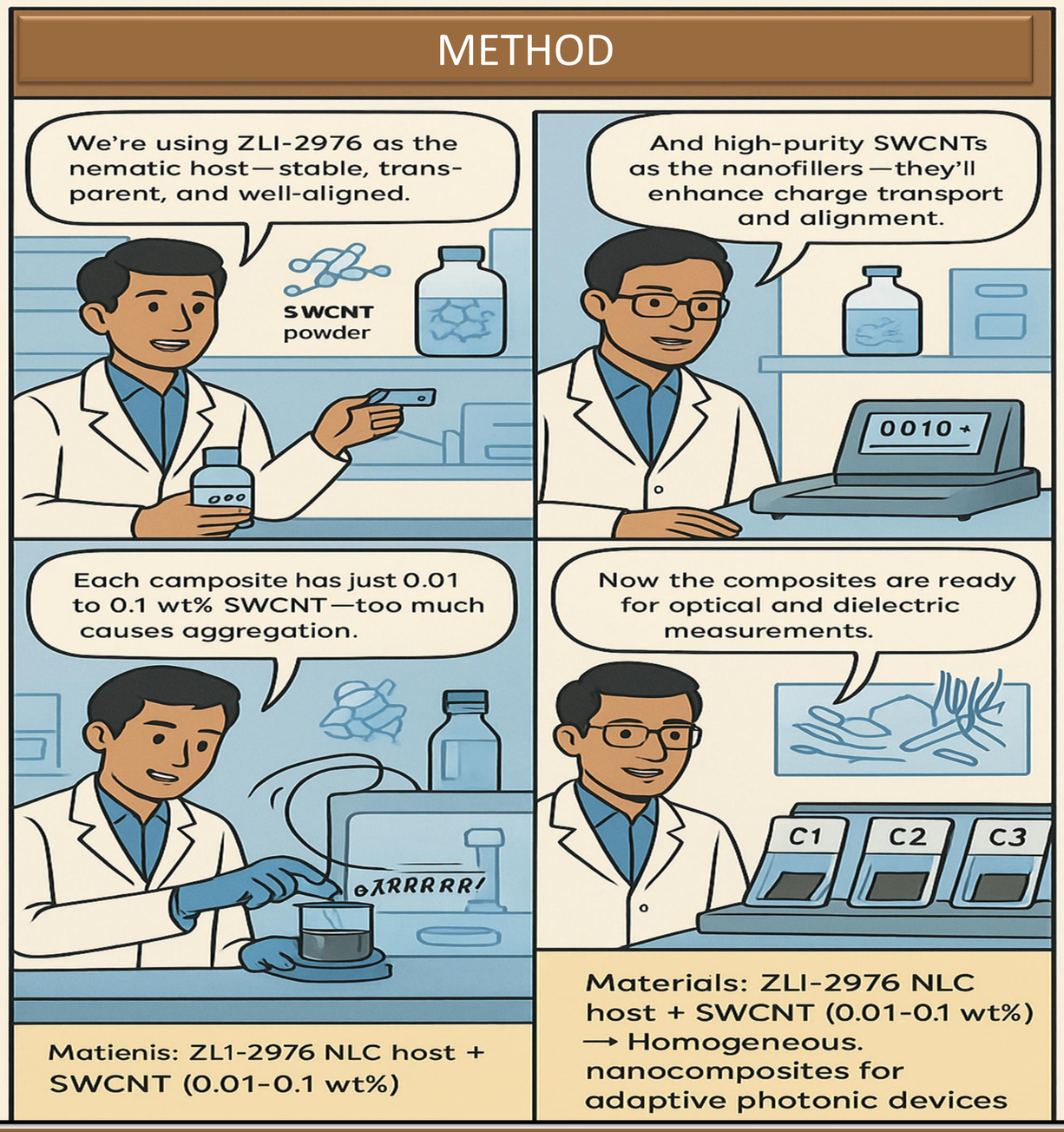


We could explore SWCNT-NLC hybrids as we can achieve fascinating tunable quantum behavior when CNTs meet with soft matter.

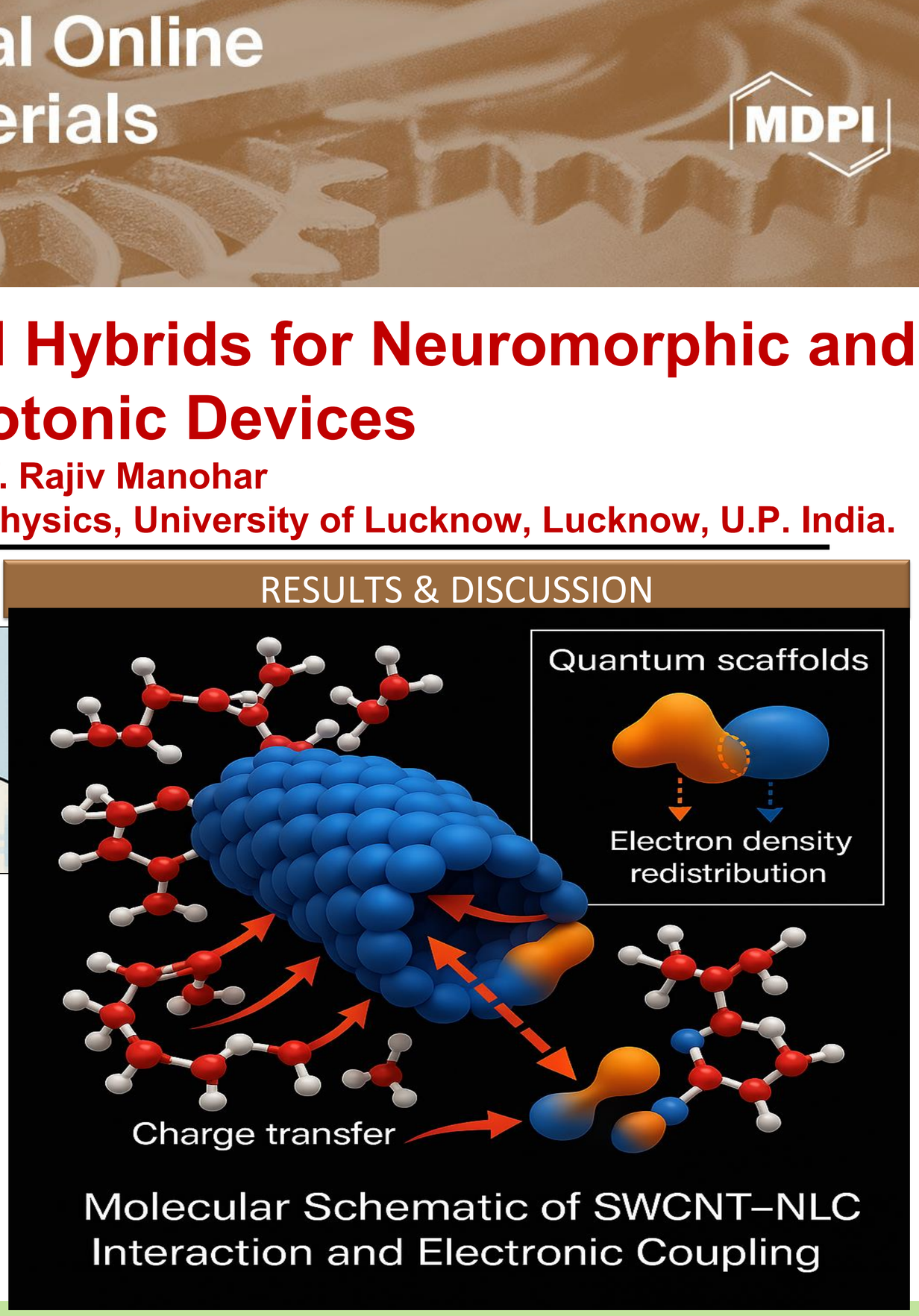
Then our goal is clear- to study their electro optic , optical and dielectric properties and see if they work as low- power adaptive photonic materials.

Aim- To develop SWCNT-NLC hybrids as adaptive electro-optic materials for neuromorphic photonic devices.

METHOD



RESULTS & DISCUSSION



Molecular Schematic of SWCNT–NLC Interaction and Electronic Coupling

Key Findings – SWCNT–NLC Hybrids

- **Threshold voltage ↓ ~82 %** → Strong field screening and improved molecular alignment.
- **Switching time ↓ ~63 %** → Faster relaxation due to nanotube–LC anchoring.
- **UV–Vis redshift (≈ 40–60 nm)** → Bandgap tunability from π–π interactions.
- **Optical bandgap ↓ 0.32 eV** → Quantum coupling enhances electronic transitions.
- **Dielectric permittivity ↑ ~62 %** → Formation of conductive percolation networks.
- **Power consumption ↓ ~65 %** → Lower drive voltage and faster response.
- **Percolation threshold ≈ 0.045 wt % SWCNT** → Onset of continuous charge pathways.
- **Photonic modulation efficiency ↑ ~85 %** → Enhanced electro-optic tuning capability.

CONCLUSION

SWCNT–NLC hybrids demonstrate quantum-enhanced electro-optic performance, offering ultra-efficient, tunable materials for next-generation neuromorphic photonic devices.

FUTURE WORK / REFERENCES

- Explore dynamic optical and neuromorphic circuit applications.
- Study long-term stability and temperature response of hybrids.