ELECTRORHEOLOGICAL PROPERTIES OF POLYANILINE-VANADIUM OXIDE NANOSTRUCTURES SUSPENDED IN SILICONE OIL

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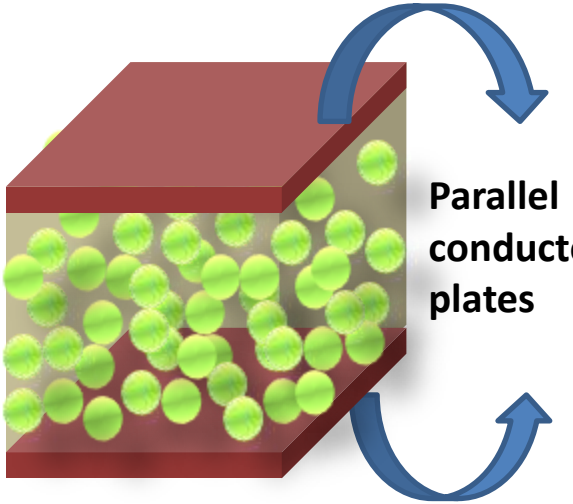
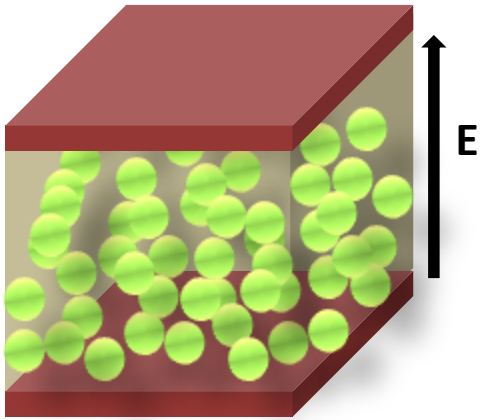
What is Electrorheological Fluid ?

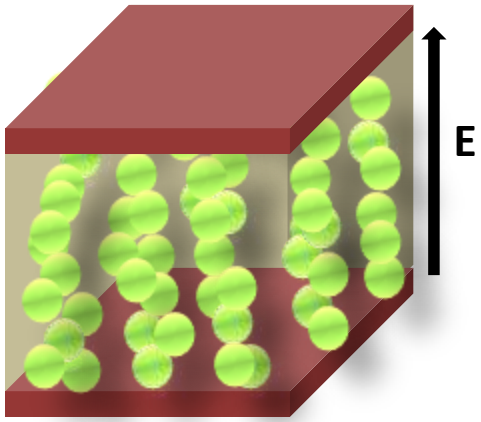
Material dispersed in non conducting media



Fluid-like

Now particles start to arrange themselves along the electric field (E)





Solid-like

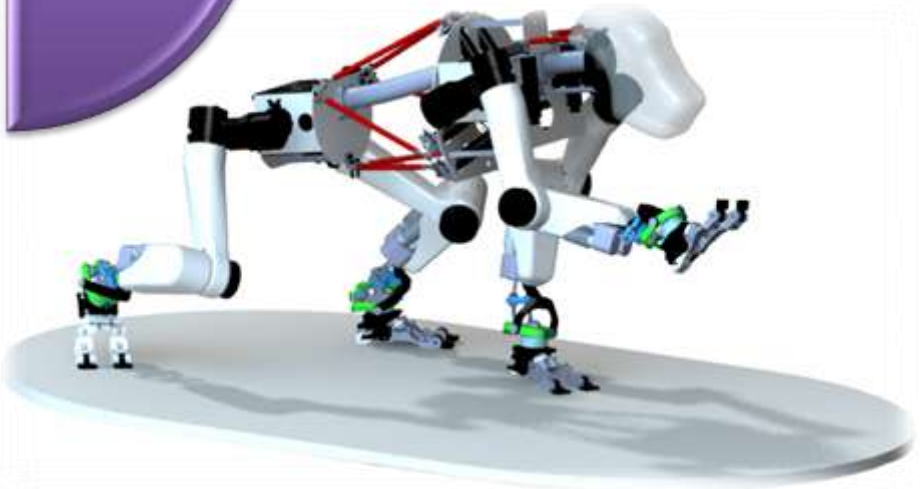
Applications...

Automobile

Artificial Knee

Damper

Robotic Arms

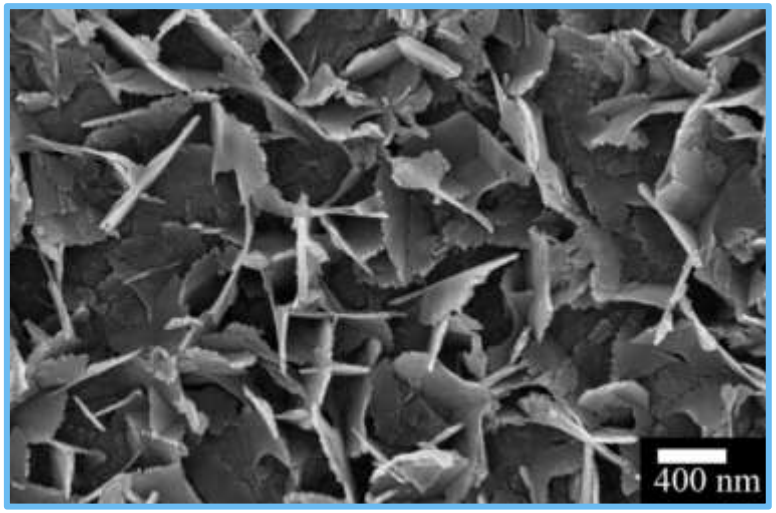


Why Polyaniline (PANI) ?

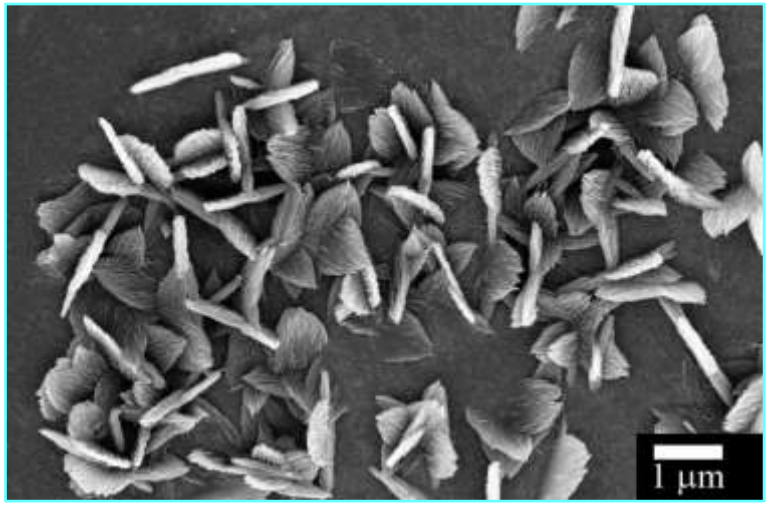
- ✓PANI is the most interesting one because it can provide a variety of advantages.
- ✓Better thermal and environmental stability
- ✓Insolubility
- ✓Intrinsic polarizability
- ✓Facile change in conductivity
- ✓Low density
- ✓Ease of synthesis
- ✓Low cost of monomer.

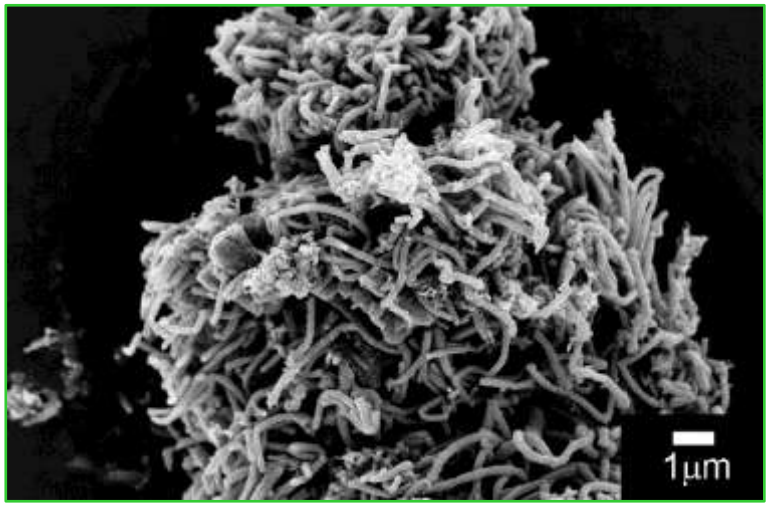
Different kind of Polyaniline NanoStructures....

Vapour Deposition



Chemical Bath





Why think of Hybridization!!!

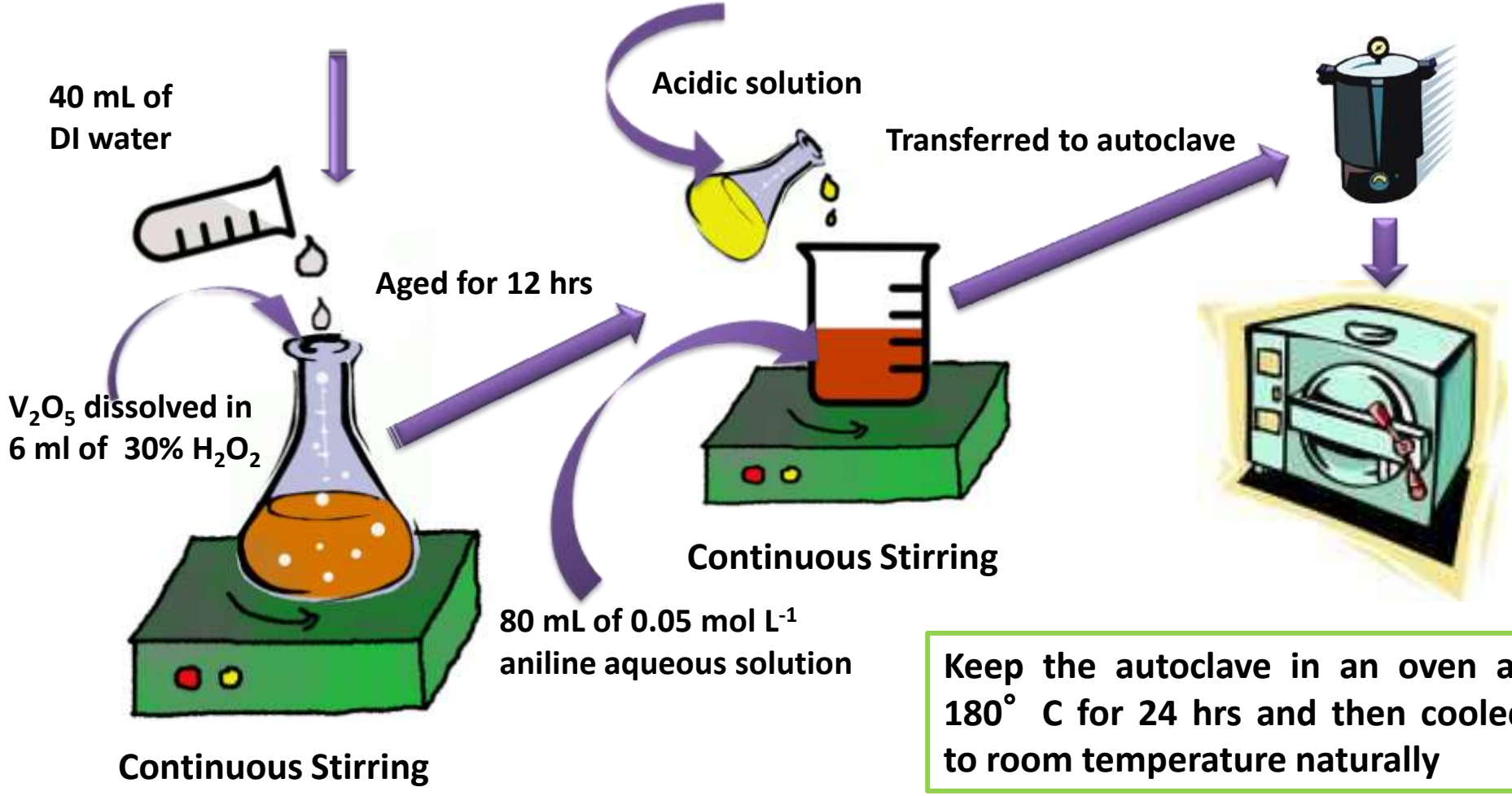
✓To improve the ER performance of the individual contents and to obtain novel synergistic ER properties which cannot be attained for individual materials.

✓To tune the conductivity of PANI to get the proper regime for ER activities.

✓To improve the polarizability.

✓To get enhanced properties with structural modification.

Hybrid Polyaniline/Vanadium Oxide Synthesis....



Keep the autoclave in an oven at 180° C for 24 hrs and then cooled to room temperature naturally

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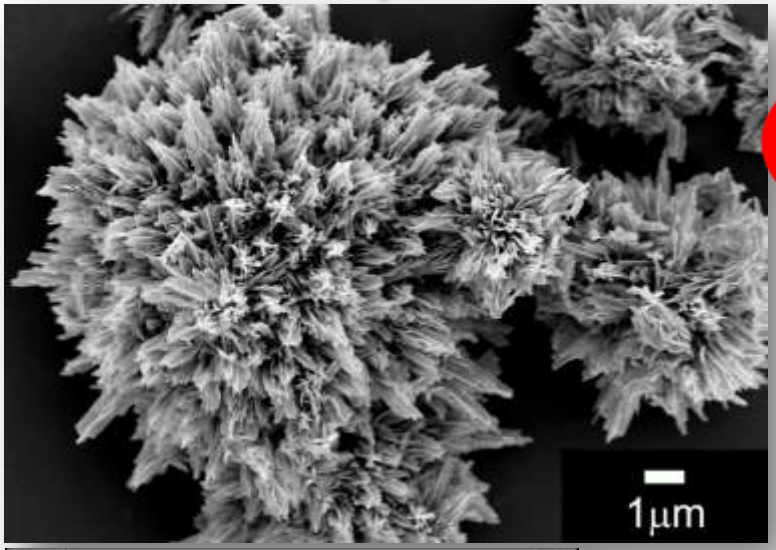
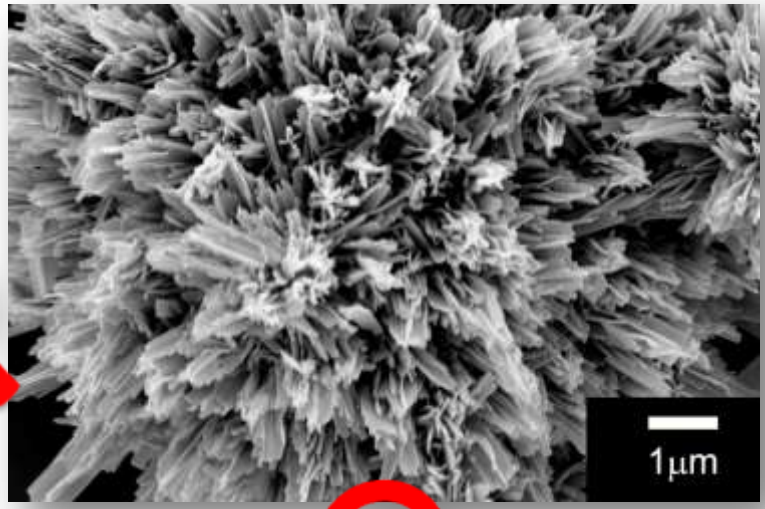
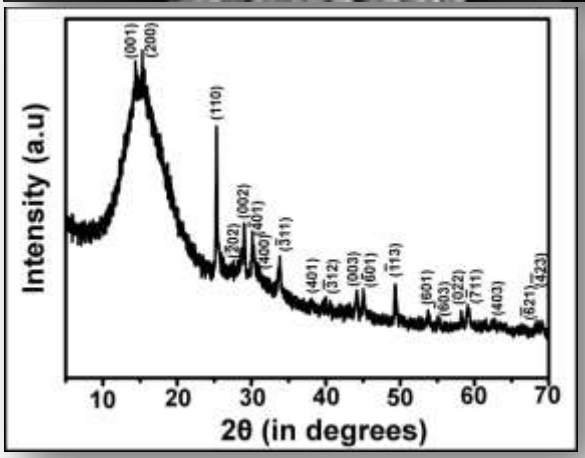
Variation in Morphology….

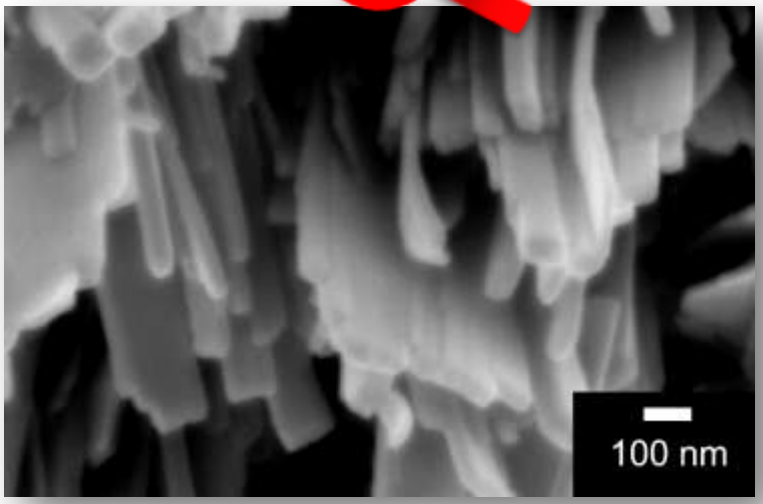
Rod-like building blocks (PAV-R)







XRD



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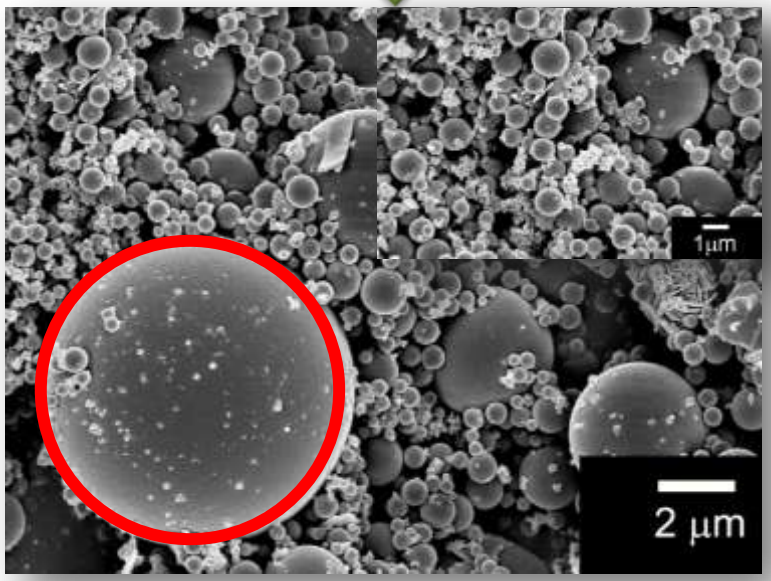
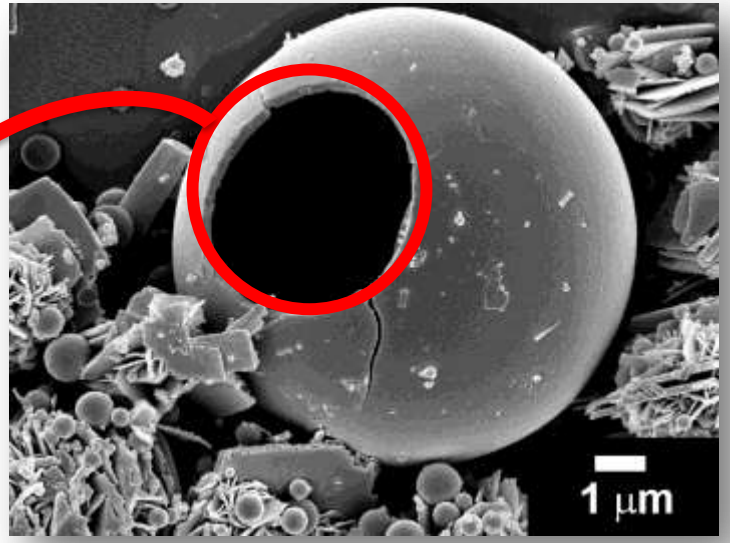
Variation in Morphology….

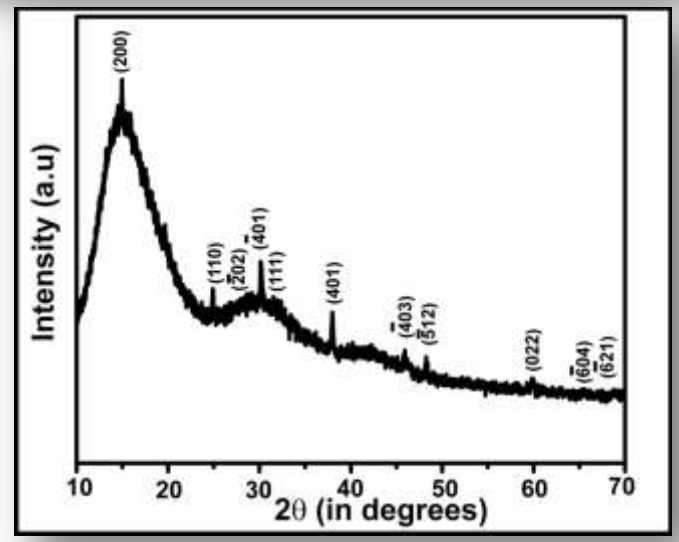
Spheres (mostly) as constituents (PAV-S)



Hollow Sphere



XRD



Cause: Concentration of the vanadic acid solution was changed.

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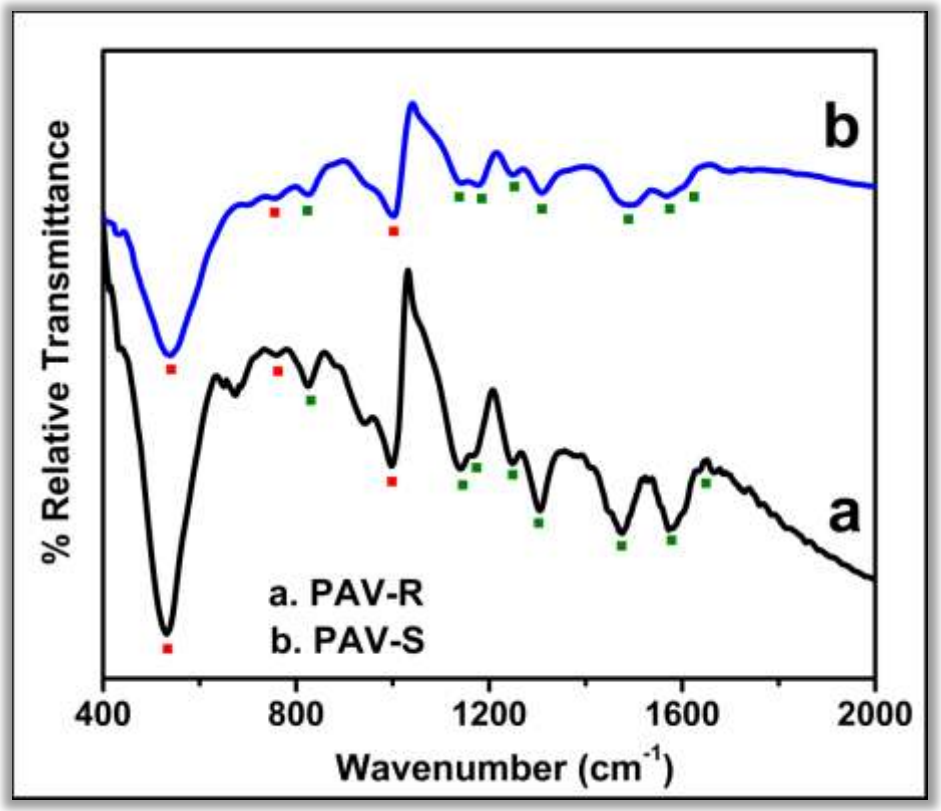
FTIR Spectra….

The bands at 1627, 1598, 1571, 1482, 1302, 1248, 1140-1170, 823 cm^{-1} are assigned as the characteristics bands of PANI in turn also confirming the presence of PANI within the composite.

The corresponding bands of VO_2 have been obtained in the region 500-1000 cm^{-1} .

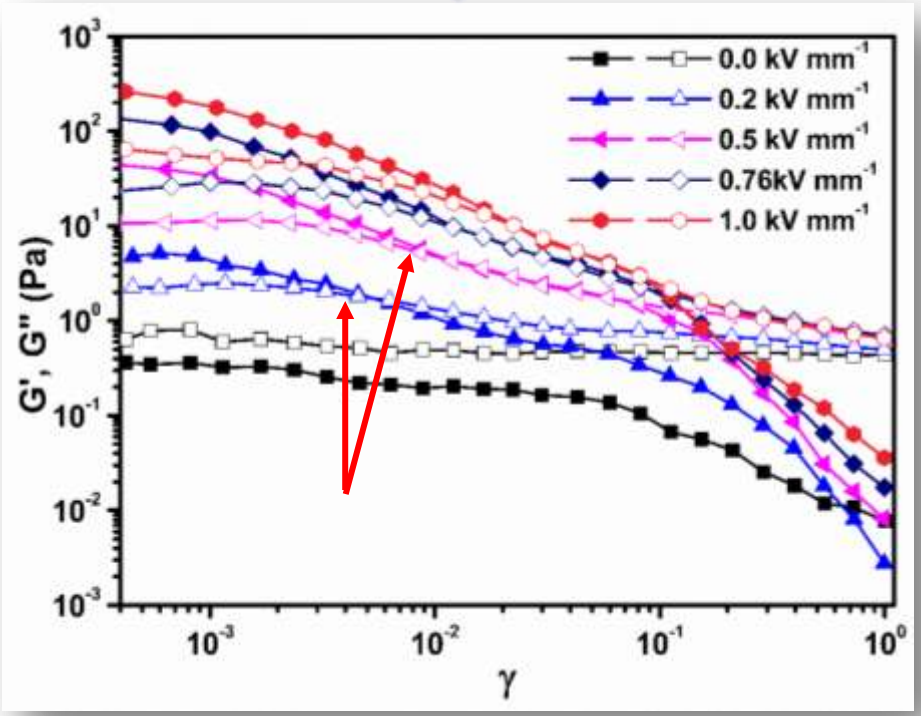
There are some small shifts in the band positions in the as-synthesized PANI/VO_2 composite with that from PANI and VO_2 individually, indicating some interaction between PANI and VO_2 in the composite.

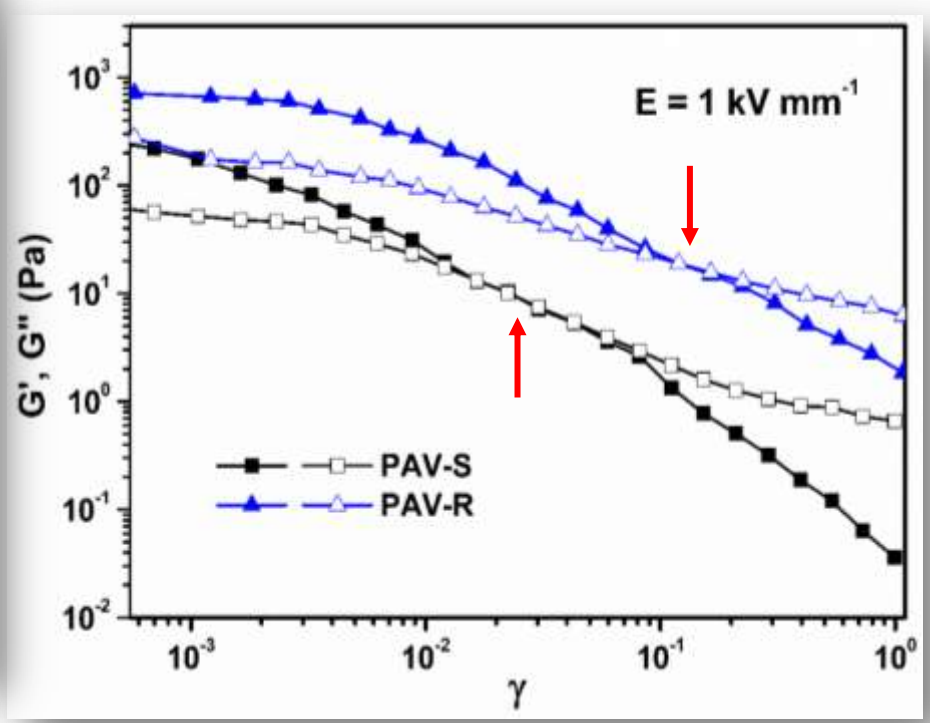


Amplitude Sweep Tests….

Storage and loss modulus (G', G") vs. strain (γ) plot. Solid symbols for G' and open symbols for G".

For PAV-S

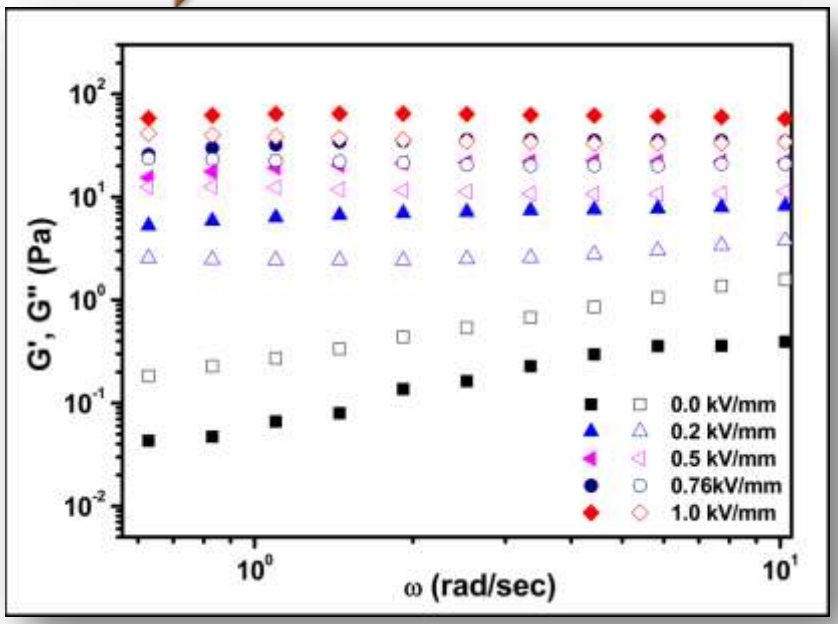




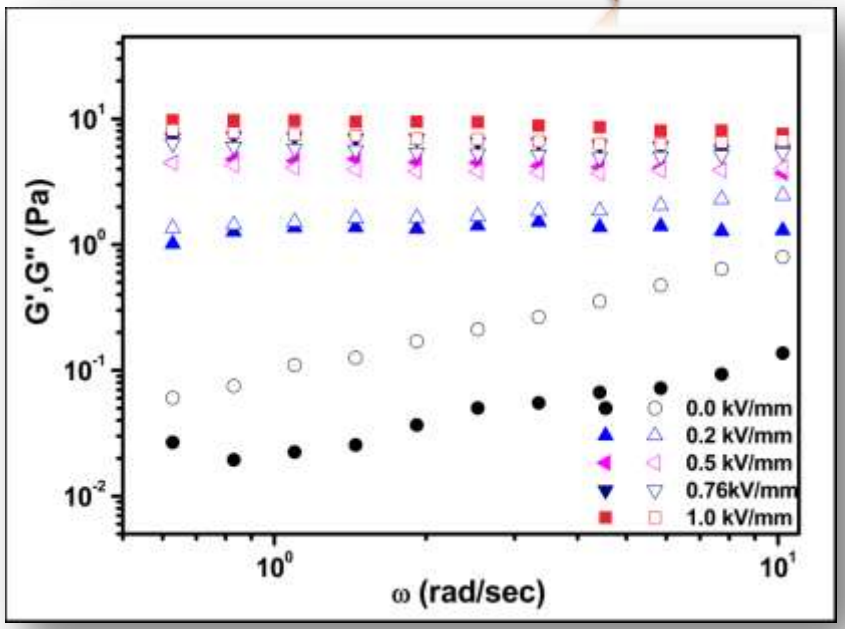
Frequency Sweep Tests….

Storage and loss modulus (G', G") vs. angular frequency (ω) plot. Solid symbols for G' and open symbols for G".

PAV-R



PAV-S



At the same electric field the values of storage modulus are much higher for PAV-R as dispersed phase indicating stronger inter-particle interaction and aligned microstructure for the rod-like particle suspension.

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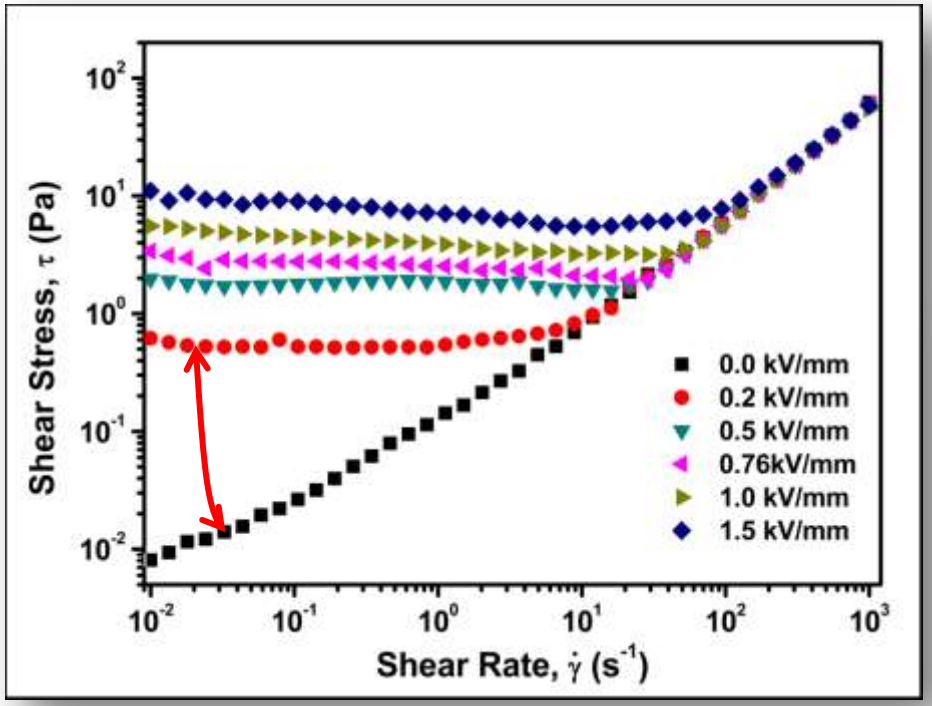
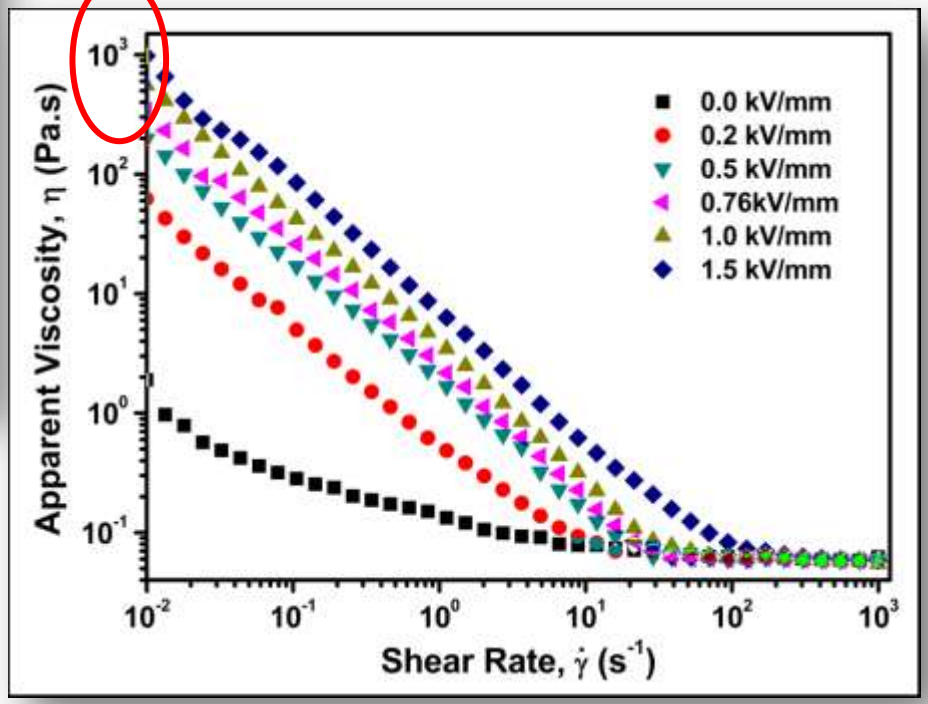
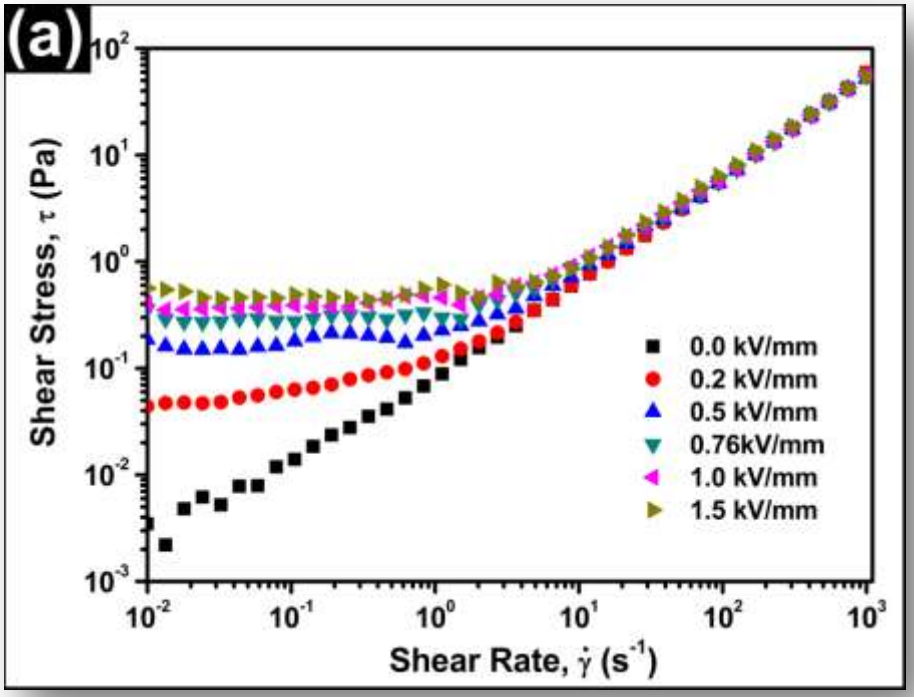
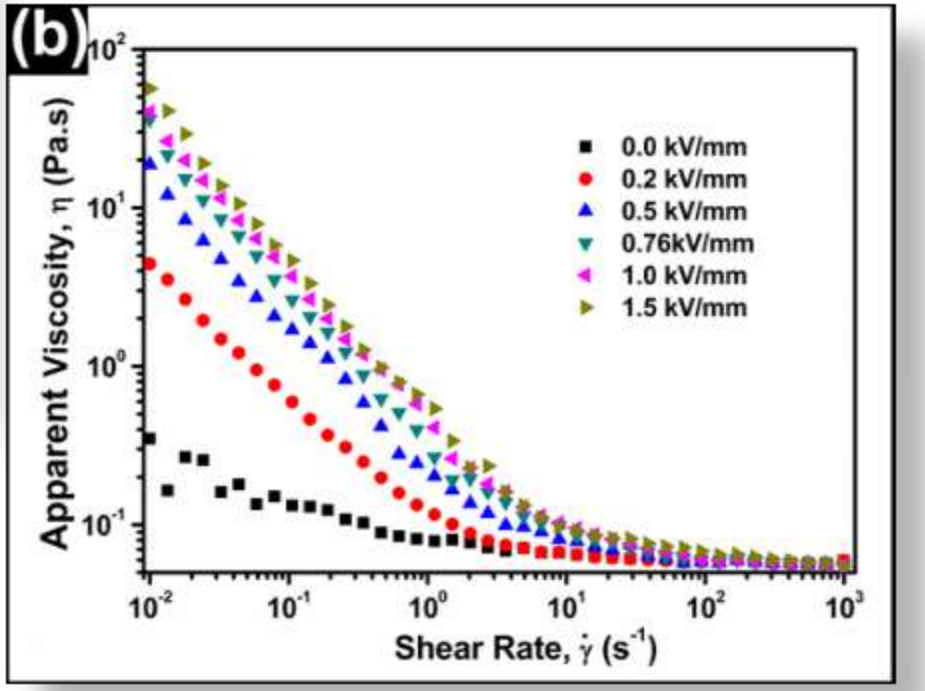
CSR mode data for ER suspension with PAV-R as the dispersed phase...





CSR mode data for ER suspension with PAV-S as the dispersed phase...





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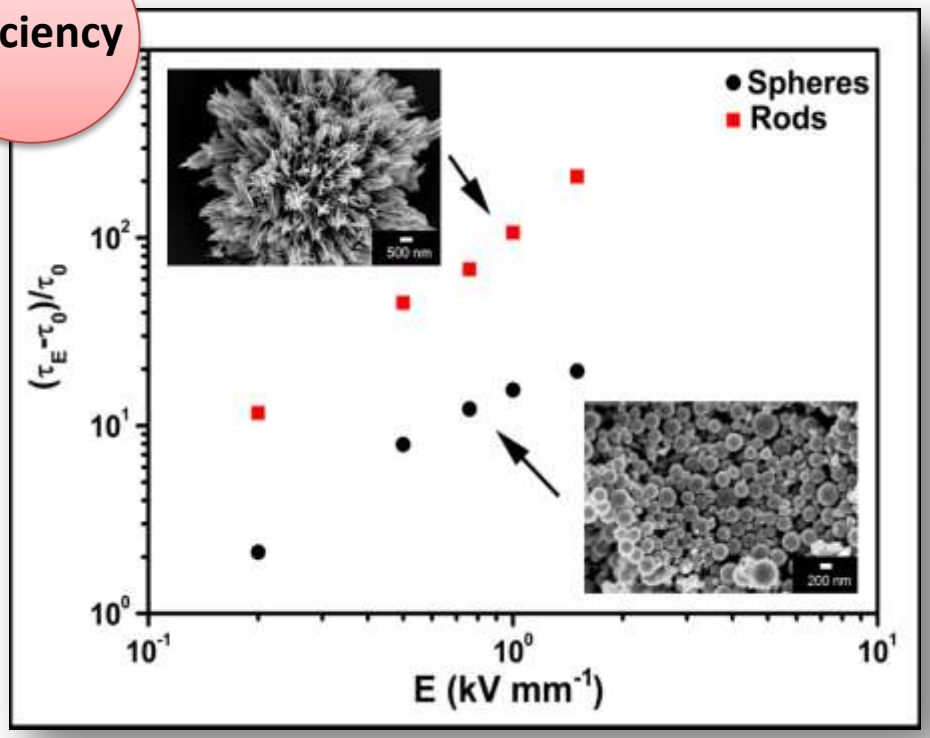
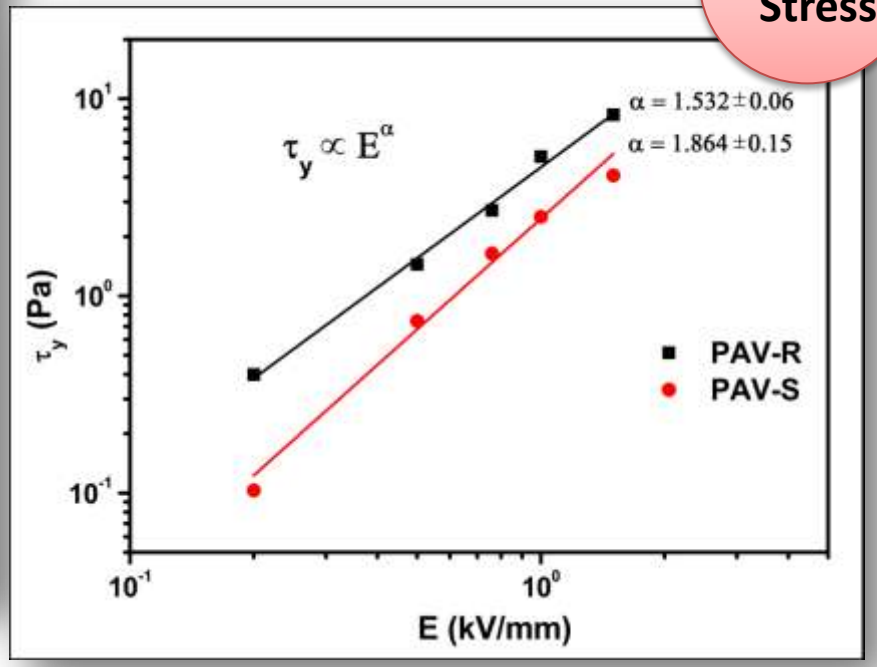
Comparison of ER efficiency and yield stress….

Efficiency



Yield Stress



ER efficiency and Yield stress for the fluids changes with electric field. The efficiency is much higher for the fluid with PAV-R in suspension.

Stronger inter-particle interaction and formation of robust dendrite-like network in presence of the applied field. Change may be attributed to the particle shape.

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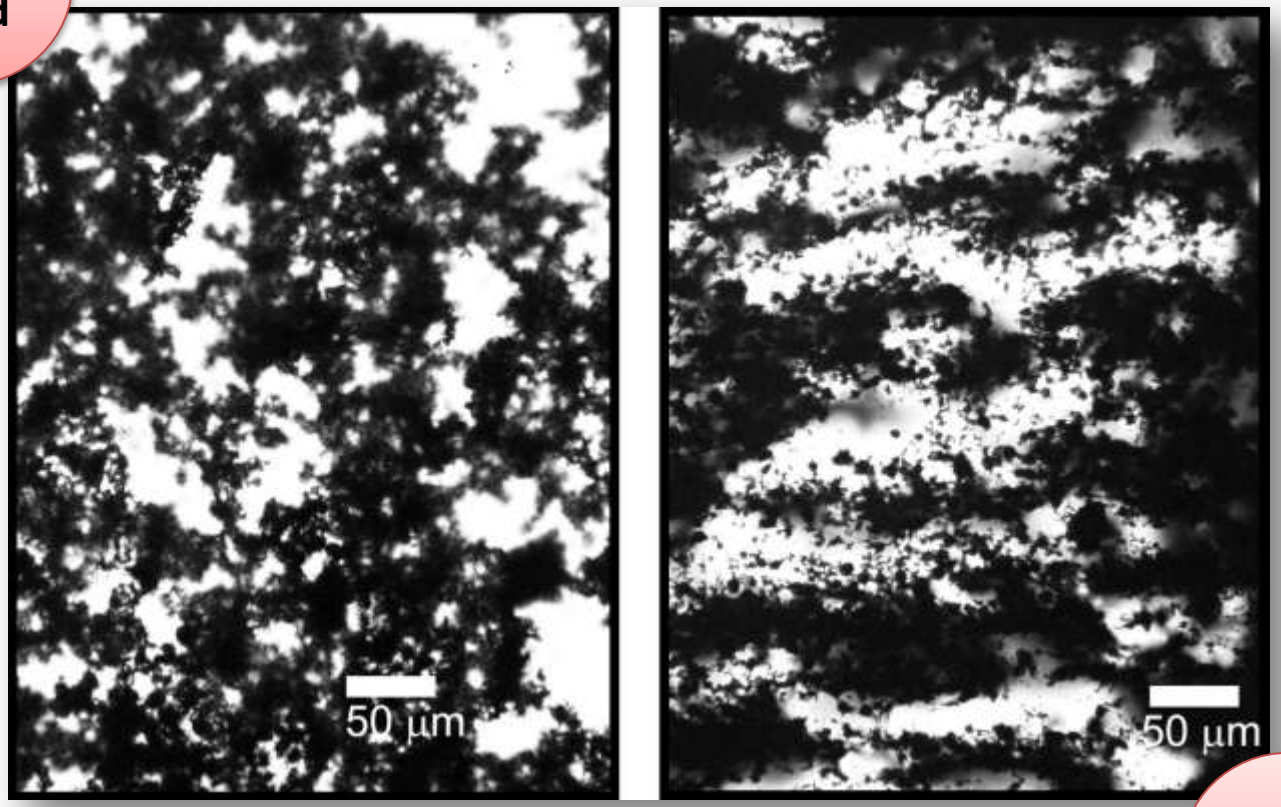
Optical Images….

Without Field



With Field

Conclusions…

✓Two different morphologies (rods and spheres as nano-scale building blocks) of polyaniline/vanadium oxide hybrid structures have been synthesized by simple hydrothermal technique.Both of these composites as dispersed phase in silicone oil have shown interesting electrorheological properties.

✓ER measurements have been performed under dynamic and steady shear and in both cases the ER fluid with rod-like particles have shown superior performances presumably due to stronger inter-particle interaction and formation of robust dendrite-like network in presence of the applied field.

✓The typical ER behaviour showed by the polyaniline-vanadium oxide nanocomposites demonstrated their potential application as an ER smart material.

Future Scopes….

To study the DIELECTRIC characteristics of these hybrid material based ER fluids as an indirect proof of their ER behaviour will be an interesting work.

To study the potential use of these polyaniline/vanadium oxide composites for sensing or energy storage applications.

Thank you for your attention

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