

STUDY OF ELECTRICAL AND MECHANICAL PERCOLATION IN POLY (PROPYLENE) / GRAPHITE COMPOSITES



Sameer Huprikar, Neelima Bulakh, E.Deendayalan, Ashish Lele*
Complex Fluids and Polymer Engineering Group, National Chemical Laboratory, India



Introduction :

Conducting thermoplastics composites are widely used for applications such as EMI shielding and RFI shielding. For such applications the percolation threshold is an important parameter which governs the optimization of mechanical properties, processability and end use electrical properties.

Motivation :

To find correlation between electrical and mechanical percolation in Poly(propylene)/Graphite composites.

Scope :

To use techniques such as

- Electrical Resistivity Measurement: Electrical percolation
- Rheology : Mechanical percolation

Materials :

- PP- Repol H200MA (Reliance Industries Limited)
- Natural Graphite
- **Carbon Black (?)**

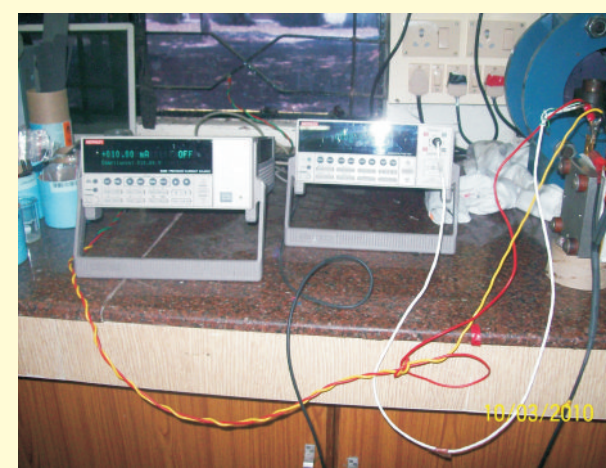
Experimental :

PP and graphite compositions in the range 0-80% (w/w) were prepared in a DSM microcompounder at 230C and 100 RPM screw speed.

Compression moulded discs were used for electrical and rheological characterization.

Dynamic Frequency Sweep experiments from 100-0.01 rad/s were performed using a strain controlled rheometer (ARES)

Through plane Electrical resistivity measurements were performed using a Keithley setup.



(a)

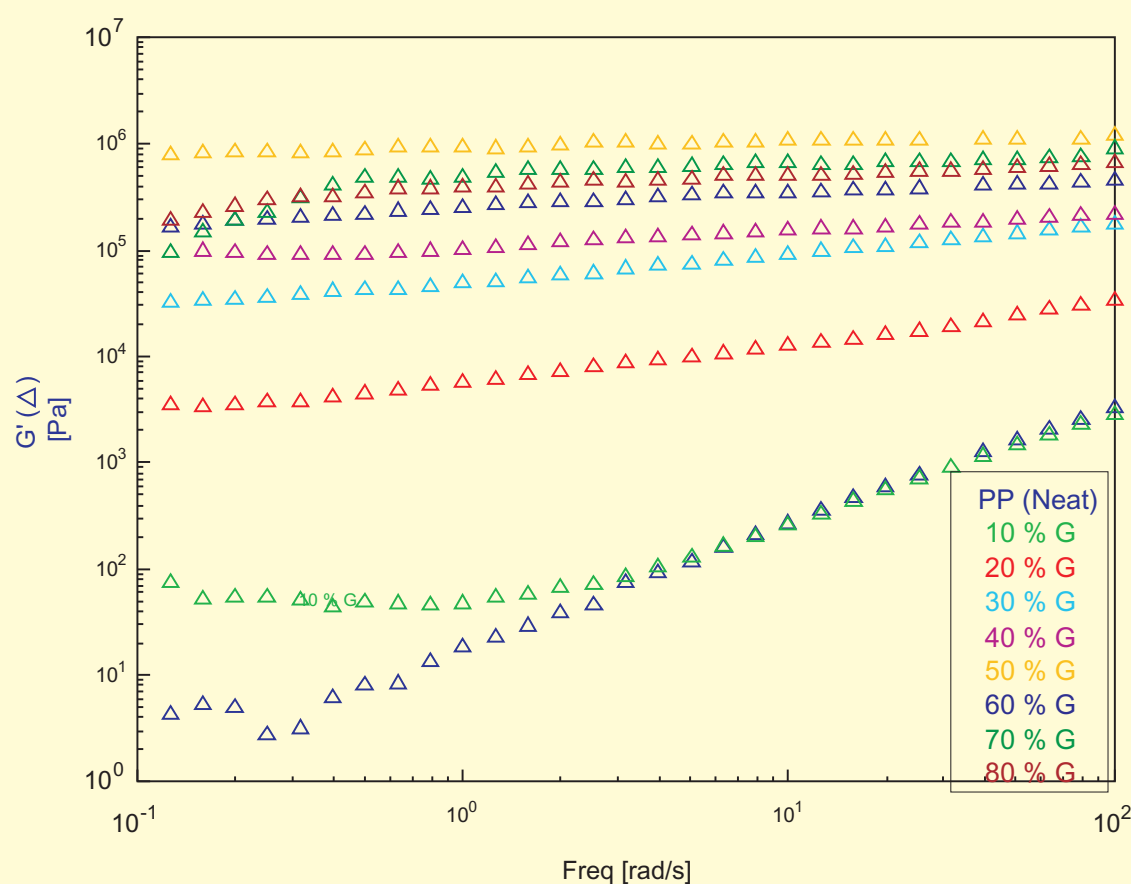


(b)

Fig (1) Through plane resistivity measurement setup

Results :

G' with frequency for all



G'' with frequency for all

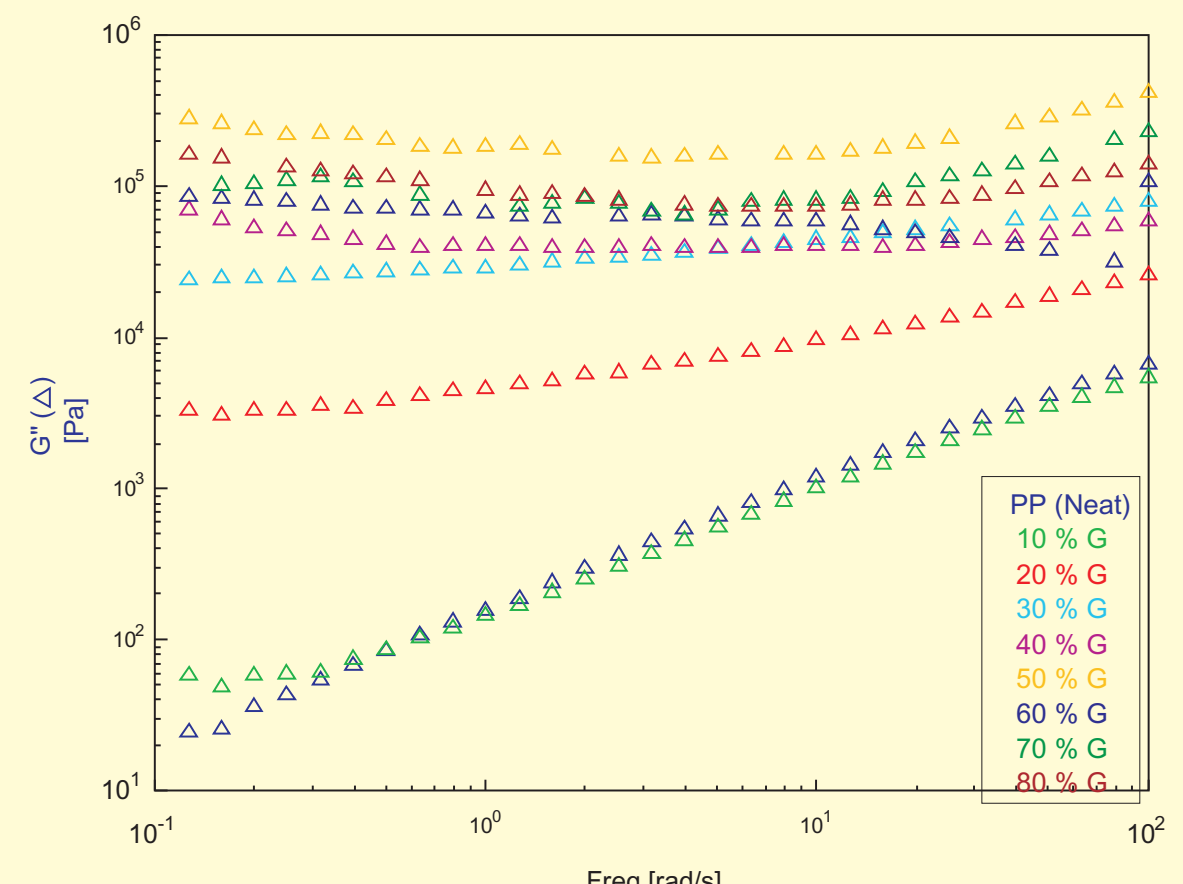
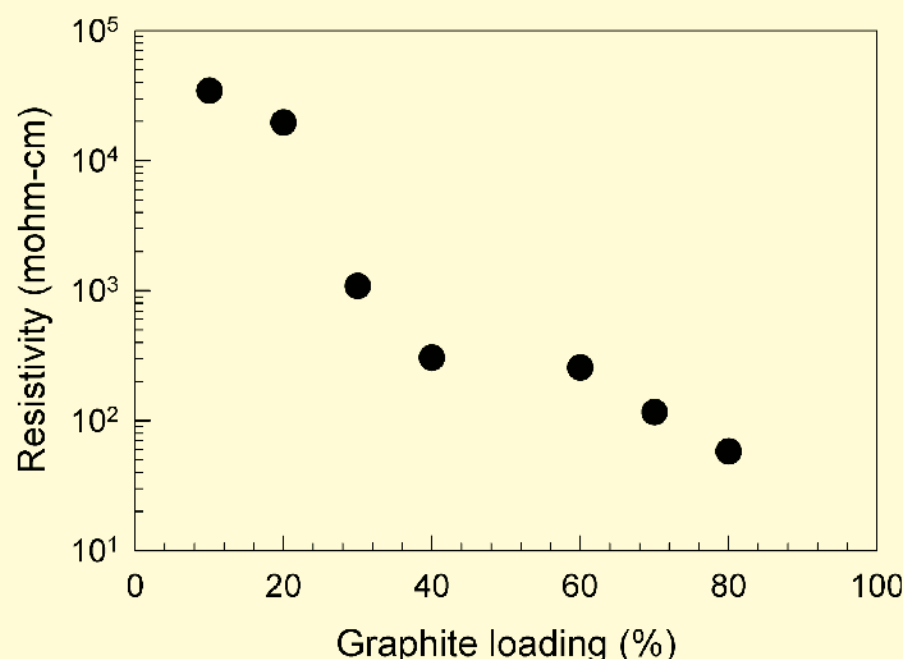


Fig (2) Rheology data

Rheology Measurements :

- Neat polypropylene exhibited typical viscoelastic behaviour.
- The 10% composite shows a plateau in G' and G'' at low frequency indicating mechanical percolation due to interaction between graphite.
- The moduli increase substantially and show weaker frequency dependence between 10% and 20% loading indicating greater percolation.
- Above 50% loading the moduli are practically frequency independent suggesting an elastic solid-like behaviour.



Electrical Measurements :

The resistivity decreases as the graphite concentration increases. There is a sharp decrease at a graphite concentration between 20% and 30% w/w, which is an indicator of the electrical percolation threshold. After percolation the resistivity decreases exponentially with graphite loading.

Fig (3) Electrical resistivity data

CONCLUSION

The mechanical percolation occurs at a lower filler percentage (10%) as compared with the electrical percolation (30%). The possible reason for this could be the presence of interactions between the filler particles in the form of load transfer through the polymer matrix, even at lower loadings. For electrical percolation on the other hand, there must be a minimum amount of contact between filler particles to form a conducting network.