Abstract - Polyester resins are used in electrical insulations. The physical, chemical and electrical properties of the resin were improved by the addition of alumina nano filler. In this research work the dielectric properties internal filed and electric susceptibility are measured at different temperature. The addition of 3%wt alumina nano filler improves the dielectric properties of the polyester resin.

Keyword- Ball mill, SEM, Al₂O₃, Resin

I. INTRODUCTION
Polyester resins are unsaturated synthetic resins formed by the reaction of dibasic organic acids and polyhydric alcohols. Maleic Anhydride is a commonly used raw material with diacid functionality. Polyester resins are used in sheet moulding compound, bulk moulding compound and the toner of laser printers. Wall panels fabricated from polyester resins reinforced with fiberglass, so-called fiberglass reinforced plastic (FRP) — are typically used in restaurants, kitchens, restrooms and other areas that require washable low-maintenance walls. Unsaturated polyesters are condensation polymers formed by the reaction of polyols (also known as polyhydric alcohols), organic compounds with multiple alcohol or hydroxy functional groups, with saturated or unsaturated dibasic acids. Typical polyols used are glycols such as ethylene glycol; acids used are phthalic acid and maleic acid. Water, a by-product of esterification reactions, is continuously removed, driving the reaction to completion. The use of unsaturated polyesters and additives such as styrene lowers the viscosity of the resin. The initially liquid resin is converted to a solid by cross-linking chains. This is done by creating free radicals at unsaturated bonds, which propagate in a chain reaction to other unsaturated bonds in adjacent molecules, linking them in the process. The initial free radicals are induced by adding a compound that easily decomposes into free radicals. This compound is usually and incorrectly known as the catalyst.

II. SYNTHESISATION OF ALUMINA (Al₂O₃) NANO FILLER
A. Properties of Al₂O₃
- Hard, wear-resistant
- Excellent dielectric properties from DC to GHz frequencies
- Resists strong acid and alkali attack at elevated temperatures
- Good thermal conductivity
- Excellent size and shape capability
- High strength and stiffnes

B. Ball Mill
Ball mill is an efficient tool for grinding many materials into fine powder. The ball mill is used to grind many kinds of mine and other materials. 10gms of Alumina micro powder was grinded for the time period of twenty hours.

C. Scanning Electron Microscope (Sem)
Scanning electron microscopy uses a focused high energy electron beam used to analyze the particle size.

III. SAMPLE PREPARATION
The solid resin samples are prepared by Accelerator and Catalyst.

A. Accelerator
Cobalt naphthenate is a mixture of cobalt derivatives of naphthenic acids. Cobalt Naphthenate is a cobalt source that is soluble in organic solvents as an organometallic compound.

B. Catalyst
Methyl ethyl ketone peroxide (MEKP) is organic peroxide, a high explosive similar to acetone peroxide. MEKP is a colorless, oily liquid whereas acetone peroxide is a white powder at STP; MEKP is slightly less sensitive to shock and temperature, and more stable in storage.

IV. EXPERIMENTAL RESULT
Dielectric spectroscopy (sometimes called impedance spectroscopy), and also known as electrochemical impedance spectroscopy (EIS), measures the dielectric properties of a medium as a function of frequency. It is based on the interaction of an external field with the electric dipole moment of the sample, often expressed by permittivity. It is also an experimental method of characterizing electrochemical systems. This technique measures the impedance of a system over a range of frequencies, and therefore the frequency response of the
system, including the energy storage and dissipation properties, is revealed. Often, data obtained by EIS is expressed graphically in a Bode plot or a Nyquist plot. Impedance is the opposition to the flow of alternating current (AC) in a complex system. A passive complex electrical system comprises both energy dissipater (resistor) and energy storage (capacitor) elements. If the system is purely resistive, then the opposition to AC or direct current (DC) is simply resistance.

Internal field and electric susceptibility are measured from the dielectric spectroscopy. The following figure 1 to 3 shows the Internal Field Vs Frequency at different temperature rating.

Figure 1 Internal Field Vs Frequency at 150°C

Figure 2 Internal Field Vs Frequency at 100°C

The electric susceptibility $\chi_e$ of a dielectric material is a measure of how easily it polarizes in response to an electric field. This, in turn, determines the electric permittivity of the material and thus influences many other phenomena in that medium, from the capacitance of capacitors to the speed of light. The following figure 4 to 6 shows the electric susceptibility Vs Frequency at different temperature rating.

Figure 3 Internal Field Vs Frequency at 50°C

Figure 4 Electric Susceptibility Vs Frequency at 150°C

Figure 5 Electric Susceptibility Vs Frequency at 100°C
CONCLUSION

The resin added with micro and nano filler solid samples were tested at dielectric spectroscopy instrument. From this work the internal filed and electric susceptibility of the polyester resin vary with temperature. The addition of 3% alumina nano filler improves the dielectric properties of the polyester resin.

References