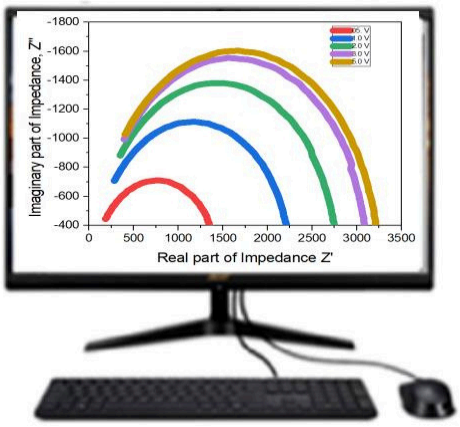
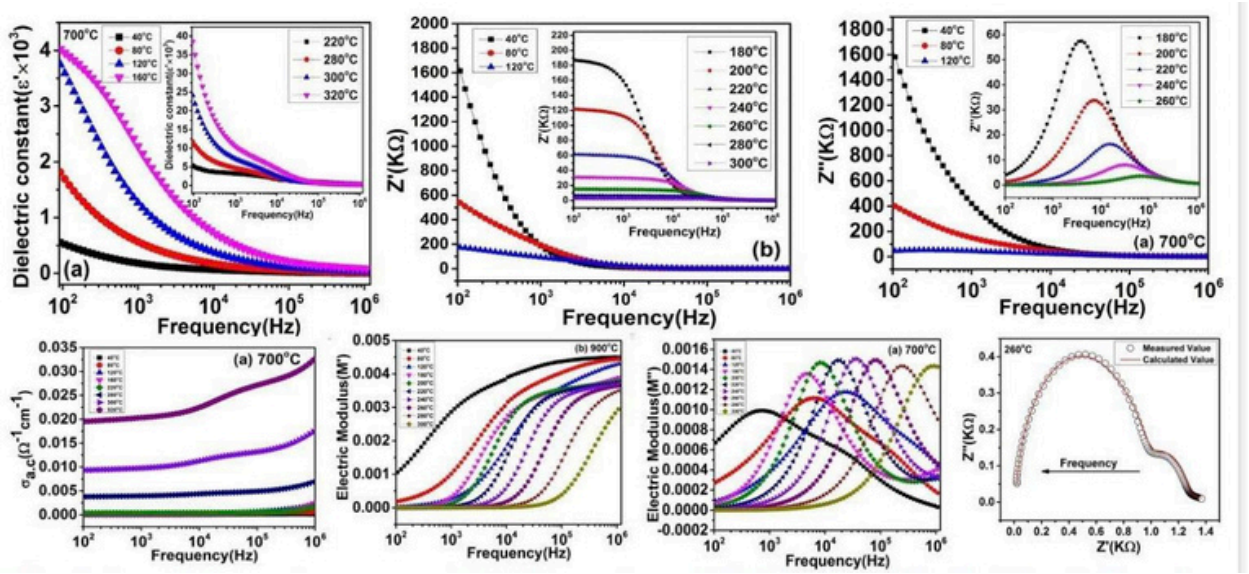
MARKSTRONICS LLC
VIRGINIA USA

DIELECTRIC MEASUREMENT SYSTEM





TECHNICAL DATA SHEET

Frequency range: 1 mHz-25 MHz

System measure the followings

SYSTEM measure 14 parameters of impedance for dielectric measurements

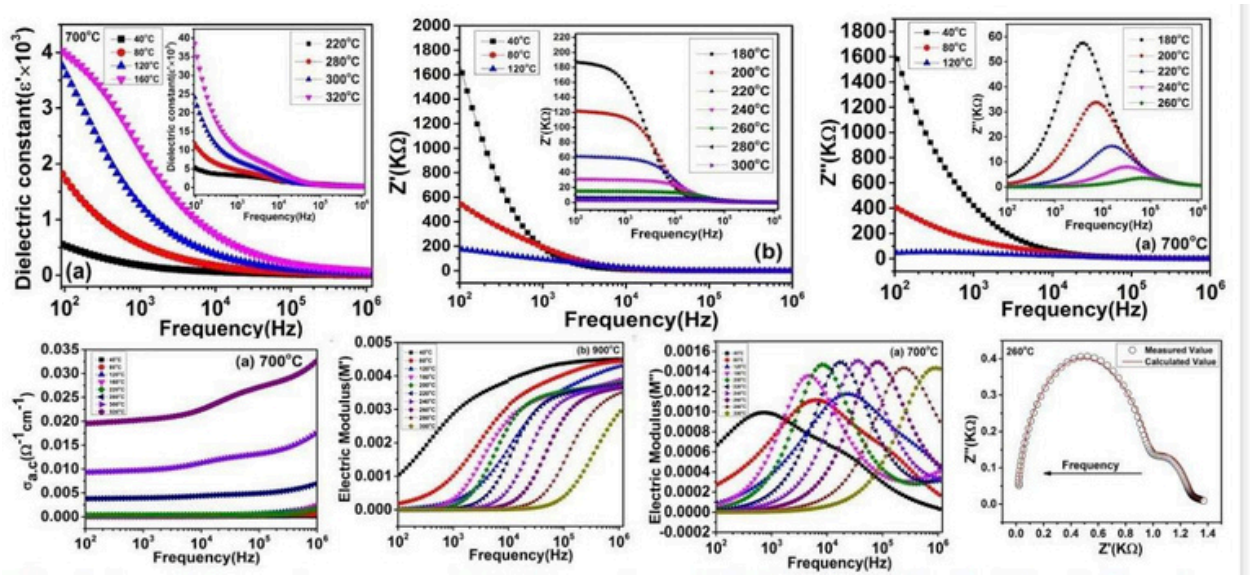
The system measure

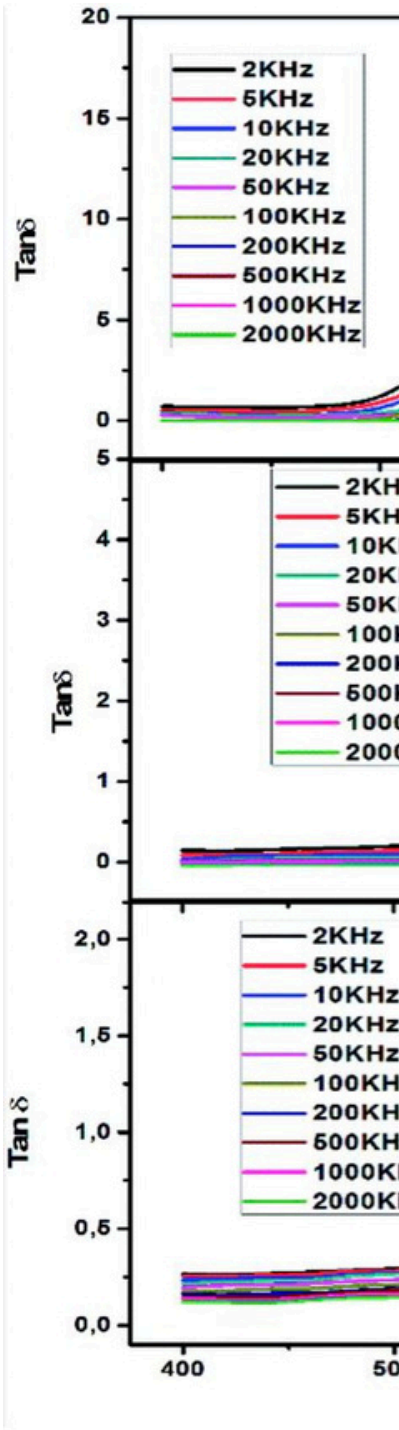
AC conductivity and dielectric parameters from room temperature to 400 K.

System simultaneously measure |Z|, |Y|, θ, Rp, Rs G, X, B, Cp, Cs, Lp, Ls, D (tanδ) parameters at constant temperature as a function of frequency

System simultaneously measure |Z|, |Y|, θ, Rp , Rs , G, X, B, Cp, Cs, Lp, Ls, D parameters at constant frequency as a function temperature

Temperature range is from room temperature to 400 K or some results for various materials.




Tanδ
2KHz
5KHz
10KHz
20KHz
50KHz
100KHz
200KHz
500KHz
1000KHz
2000KHz
Tanδ
Tan δ
400

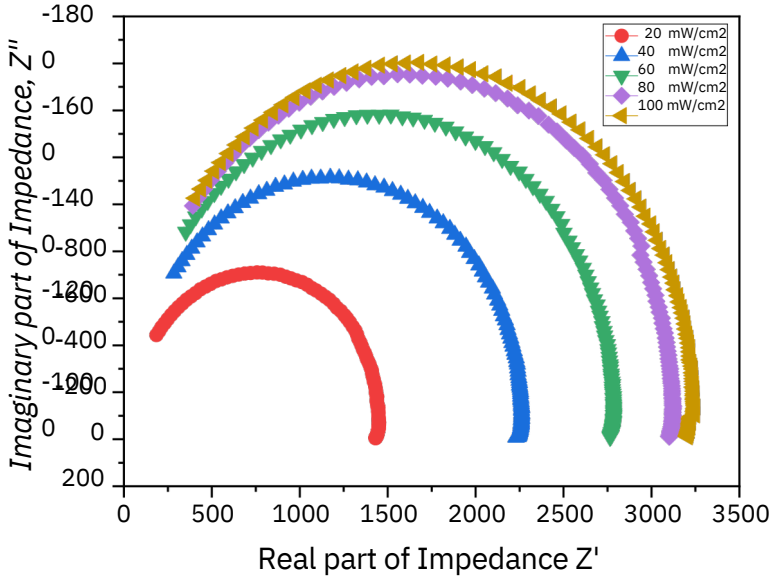


Fig.1 Nyquist Plot of silicon solar cell under various light intensities

Bode and Nyquist Plot In this chapter the two main ways of visualizing Electrochemical Impedance Spectra (EIS), the Nyquist and Bode plot, are presented and it is explained how different EIS of easy electronic circuits will be plotted in the Bode and Nyquist plot. This demonstrates the advantages and disadvantages of the two plots as well as serving as a foundation to understand the analysis of EIS by utilizing equivalent circuits. As mentioned in the previous chapter there are two main ways to plot an impedance spectrum. One is the Bode plot. This plot is actually two plots in one. The abscissa is a logarithmic scale of the frequency and one ordinate is the logarithm of the impedance Z while the second ordinate is the phase shift Φ. The advantage of this plot is that all information is clearly visible. A capacitor in parallel to a resistor, which is an important circuit for electrochemical impedance spectroscopy, is visible in this spectrum as a peak in the phase shift. Single components can be easier understood in the Bode plot.

The Nyquist plot is more complex to understand, but due to practical reasons is more popular in electrochemistry. One reason is that the Nyquist plot is very sensitive to changes. Another is that for the most common circuits some parameter can be read

directly from the plot. To get a Nyquist plot the negative imaginary impedance –Z'' is plotted versus the real part of the impedance Z'. In the following paragraphs some simple components effects on a Bode plot and Nyquist plot will be shown. This is useful, because it is common to create an electronic circuit that represents the electrochemical system under investigation

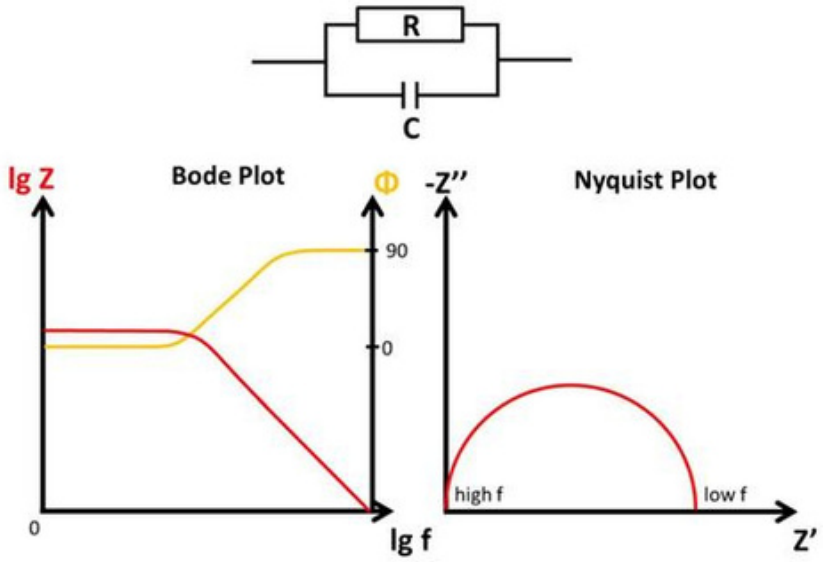


Fig.4 Nyquist and Bode Plots of material