

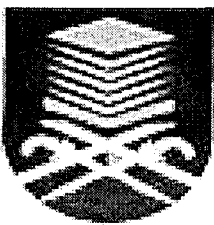
**THE FREE SPACE TRANSMISSION-REFLECTION METHOD TO
DETERMINE OF COMPLEX PERMITTIVITY AND COMPLEX
PERMEABILITY OF THE DIFFERENT FILLERS RUBBER
MATERIALS AT MICROWAVE FREQUENCIES**

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ABSTRACT

The main objective of this project is to develop a free space measurement system at microwave frequencies in the frequency range of 7.5 to 12 GHz (X-band) for measured a reflection coefficient, S_{11} and transmission coefficient, S_{21} of the different filler composition for two major filler which is Carbon Black and China Clay (i.e. 20 part per hundred rubber (pphr) carbon black or 40pphr china clay) for natural rubber. The complex permittivity and complex permeability is calculated from the measured values of S_{11} and S_{21} .

Second objective is to proved that increasing a composition of filler will increased the complex permittivity or electrical constant (ϵ^*). Third is to proved that rubber is non magnetic material rubber which is gives a complex permeability (μ^*) equal to 1 for real and 0 for imaginary part. Finally, to prove that the carbon black rubbers have higher conductivity properties compared to the china clay rubbers.

The key components of the measurements system consist of transmit and receive spot-focusing horn lens antenna, and the vector network analyzer. For thin, flexible samples, the sample had to be sandwiched between two half-wavelength (at mid band) Teflon plate, to eliminate the effect of sagging. Because of the far-field focusing ability of horn lens antennas free-space measurement can be made at microwave frequency in a relatively compact and simple measurement setup.

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CHAPTER 1

INTRODUCTION

1.1 The Electromagnetic Model

There are two approaches in the development of a scientific subject; the inductive approach and the deductive approach. Using the inductive approach, one follows the historical development of the subject, starting with the observations of some simple experiments and inferring from them laws and theorems. It is process of reasoning from particular phenomena to general principles. A deductive approach, on the other hand, postulates a few fundamental relations for an idealized model. The postulated relations are axioms, from which particular law theorems can be derived [1].

Three essential steps are involved in building a theory on an idealized model. First, some basic quantities germane to the subject of study are defined. Second, the rules of operations of these quantities are specified. Third, some fundamental relations are postulated. In this case the basis quantities are voltages (V), current (I), resistance (R), inductance (L) and capacitance (C). The rules of the operations are those of algebra, ordinary different equations, Laplace transformation, and the fundamental postulates are Kirchoff's voltage and current law [1].

The quantities in electromagnetic model can be divided roughly into two categories; source quantities and field quantities. The source of an electromagnetic field is invariably electric charges at rest or in motion. However, an electromagnetic field may be cause a redistribution of charges, which will, in turn, change the field; hence the separation between the cause and the effect is not always so distinct.

We use the symbol q (sometimes Q) to denote electric charge. Electric charge is a fundamental property of matter and exists only in positive or negative integral multiples of the charges of an electron: