



UNIVERSITI PUTRA MALAYSIA

**PERFORMANCES ANALYSIS OF LINEAR AND CIRCULAR
MICROSTRIP METHODS FOR DETERMINATION OF MOISTURE
CONTENT IN RUBBER LATEX**

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**PERFORMANCES ANALYSIS OF LINEAR AND CIRCULAR
MICROSTRIP METHODS FOR DETERMINATION OF MOISTURE
CONTENT IN RUBBER LATEX**

By

AHMAD FAHAD AHMAD

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,
in Fulfilment of the Requirements for the Degree of Master of Science**

January 2011



To My past Father and mother (Allah bless them),

--- and ---

My lovely wife and sons,

For their great patience and encouragement

And

My lovely country Iraq



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in
Fulfilment of the Requirement for the Degree of Master of Science

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Chairman: Zulkifly Abbas, PhD

Faculty: Science

Following a review of methods for measuring the microwave properties of dielectric materials and moisture measurement methods, majority of the thesis is concerned with the design, construction, and calibration of two different types of microstrip sensors for the determination of moisture content in rubber latex. The Microwave Office 2002 (MWO) was used to design both sensors the linear path and circular ring microstrip lines operating in the frequency range between 2 GHz and 3 GHz which gave the high correlation between dielectric properties and moisture content of latex. S-parameters of the sensors were measured using Professional Network Analyzer (PNA).

The microwave properties of interests were attenuation and Q-factor, the main focus of this thesis was to establish the relationship between the microwave properties of



the sensors and moisture content in the rubber latex. The actual moisture content was found from standard oven drying method. The theoretical part described the variation in attenuation with frequency for various percentages of moisture content of the sample. The analysis was used to determine the optimum permittivity, width, height and impedance of the microwave substrate for a wide dynamic input range of the sensors. The sensors were fabricated and tested for a range of moisture content. All the sensors were calibrated using standard microwave calibration techniques. Additionally, calibration equations were developed to establish the empirical relationship between the measured attenuation and Q-factors with the actual moisture content. All the results were validated with the actual moisture content.

The microstrip ring and line sensor were successfully developed in prediction of moisture content for rubber latex. Both sensors give a different performance in term of sensitivity and mean error. The microstrip line sensor gives a good sensitivity compared to microstrip ring sensor with sensitivity for microstrip linear and microstrip ring sensors are 13.698 %/dB and 3.0697 %/dB respectively. While the microstrip ring sensor gives a smaller mean error compared to microstrip line sensor with mean error for microstrip ring and line sensor are 0.023 and 0.095 respectively.



Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

**ANALISIS PRESTASI KAEDAH JALUR LINEAR DAN JALUR CINCIN
UNTUK PENENTUAN KELENGASAN SUSU GETAH**

Oleh

AHMAD FAHAD AHMAD

January 2011

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Berdasarkan ulasan dari kaedah untuk mengukur sifat mikrogelombang bahan dielektrik dan kaedah pengukuran kadar kelengasan, majoriti tesis adalah berkaitan dengan rekabentuk, pembinaan, dan kalibrasi dari dua jenis sensor mikrojalur untuk penentuan kadar kelengasan di dalam lateks getah. Microwave Office 2002 (MWO) digunakan untuk merekabentuk kedua-dua sensor lingkaran cincin dan garbs lurus mikrojalur yang beroperasi di rantau frekuensi antara 2 GHz dan 3 GHz yang memberikan korelasi tinggi antara sifat dielektrik dan kadar kelengasan lateks. S-parameter sensor telah profesional dengan menggunakan PNA.

Sifat gelombang mikro yang diminati adalah pemerosotan dan factor-Q. Fokus utama tesis ini adalah berkaitan dengan rekaan, binaan dan penentukuran pada dua jenis

sensor mikrojalur yang berbeza untuk menentukan kelengasan susu getah. Kelengasan sebenar dicari daripada kaedah piawai pengeringan ketuhar.

Bahagian teori menerangkan variasi pemerosotan dengan frekuensi untuk pelbagai peratusan kelengasan pada sampel. Analisis telah digunakan untuk menentukan ketelusan, lebar, tinggi dan impedans yang optimum pada substrat gelombang mikro untuk julat input dinamik yang besar pada sensor. Sensor telah dibuat dan diuji untuk julat kelengasan. Semua sensor telah ditentukan menggunakan teknik tentukan piawai gelombang mikro. Selain itu persamaan penentuan telah dibangunkan untuk menegakkan hubungan empirikal antara pemerosotan dan faktor-Q yang diukur dengan kelengasan sebenar. Semua hasil telah disahkan dengan kelengasan sebenar.

Sensor mikrojalur cincin dan sensor mikrojalur garis lurus telah berjaya dikembangkan untuk menentukan kelengasan lateks getah. Kedua-dua sensor memberikan prestasi yang berbeza dalam hal sensitiviti dan ralat. Sensor mikrojalur garis lurus memberikan sensitiviti yang lebih baik berbanding dengan sensor mikrojalur cincin dengan sensitiviti untuk sensor mikrojalur garis lurus ialah 13.698% / dB manakala sensitiviti untuk sensor mikrojalur cincin ialah 3.0697% / dB. Sementara sensor mikrojalur cincin memberikan ralat lebih kecil berbanding dengan sensor mikrojalur garis lurus dengan ralat untuk sensor mikrojalur cincin ialah 0.023 dan ralat untuk sensor garis lurus ialah 0.095.

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I certify that an Examination Committee has met on xxx 2010 to conduct the final examination of Ahmad Fahad Ahmad on his Master of Science thesis entitled “Comparative performance analysis between linear and circular microstrip methods for determination of moisture content in rubber latex” in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U. (A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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DECLARATION

I declare that the thesis is my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or other institutions.

AHMAD FAHAD AHMAD

Date: 14 January 2011



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