

# VARIABLE FREQUENCY MICROWAVE CURING OF POLYURETHANE

Diane C. Folz

Thesis submitted to the faculty of the Virginia Polytechnic Institute and State University  
in partial fulfillment of the requirements for the degree of

Master of Science in  
Materials Science and Engineering

David E. Clark  
Gary S. Pickrell  
Robert W. Hendricks

19 July 2011  
Blacksburg, Virginia

Keywords: microwave processing, FTIR spectroscopy, attenuated total reflectance, cure rate, polymer coatings, wood coatings

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Draft 09/01/2009

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## Virginia Tech ETD Fair Use Analysis Results

*This is not a replacement for professional legal advice but an effort to assist you in making a sound decision.*

Name: Diane Folz

Description of item under review for fair use: Folz thesis Fig. 2.1: unlabeled figure, 5th down on the right, "electromagnetic spectrum" in [www.newworldencyclopedia.org](http://www.newworldencyclopedia.org), New World Encyclopedia, accessed July 2011.

Report generated on: 09-04-2011 at : 06:48:55

### Based on the information you provided:

#### Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

#### Factor 2

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

#### Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

#### Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: *in*

*favor of fair use*

**Based on the information you provided, your use of the copyrighted work weighs: *in favor of fair use***



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# Virginia Tech ETD Fair Use Analysis Results

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Name: Diane Folz

Description of item under review for fair use: Folz thesis Fig. 2.10: Figure 4.20: Examples of specular and diffuse reflectance. from, FUNDAMENTALS OF FOURIER TRANSFORM INFRARED SPECTROSCOPY, B.C. Smith, CRC Press, Inc., New York, NY, 1996, p. 109.

Report generated on: 09-04-2011 at : 07:38:46

## **Based on the information you provided:**

### **Factor 1**

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

### **Factor 2**

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

### **Factor 3**

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

### **Factor 4**

Your consideration of the effect or potential effect on the

market after your use of the copyrighted work weighs: *in favor of fair use*

**Based on the information you provided, your use of the copyrighted work weighs: *in favor of fair use***



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## Virginia Tech ETD Fair Use Analysis Results

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Name: Diane Folz

Description of item under review for fair use: Folz thesis Fig. 2.11: Figure 4.26: A schematic illustration of an attenuated total reflectance accessory. from, FUNDAMENTALS OF FOURIER TRANSFORM INFRARED SPECTROSCOPY, B.C. Smith, CRC Press, Inc., New York, NY, 1996, p. 109. Figure 6: Internal reflection elements used to obtain interaction of the exciting radiation with the sample. from INTERNAL REFLECTION SPECTROSCOPY: THEORY AND APPLICATIONS, F.M. Mirabella, Marcel Dekker, Inc. New York, NY, p. 31.

Report generated on: 09-04-2011 at : 07:52:51

### Based on the information you provided:

#### Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

#### Factor 2

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

#### Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

#### Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: *in favor of fair use*

**Based on the information you provided, your use of the copyrighted work weighs: *in favor of fair use***



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Name: Diane Folz

Description of item under review for fair use: Folz thesis Fig. 2.12: this figure was drawn by the author, based on conversations with and electronic communications from J. Simonis, Thermo Electron Corporation, July 2011.

Report generated on: 09-04-2011 at : 08:03:21

## **Based on the information you provided:**

### **Factor 1**

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

### **Factor 2**

Your consideration of the nature of the copyrighted work you used weighs: *against fair use*

### **Factor 3**

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

### **Factor 4**

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: *in*



*favor of fair use*

**Based on the information you provided, your use of the copyrighted work weighs: *in favor of fair use***



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Report generated on: 09-04-2011 at : 08:04:45

### Based on the information you provided:

#### Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

#### Factor 2

Your consideration of the nature of the copyrighted work you used weighs: *against fair use*

#### Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

#### Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: *in*

*favor of fair use*

**Based on the information you provided, your use of the copyrighted work weighs: *in favor of fair use***



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Name: Diane Folz

Description of item under review for fair use: Folz thesis Fig. 2.14: no figure number: "The illustration below shows a top view of the optical layout of an Avatar spectrophotometer with covers removed to reveal components. from, ThermoNicolet Avatar 330 FTIR User's Manual, ThermoElectron Corporation, 2001, p. 47.

Report generated on: 09-04-2011 at : 08:19:08

## **Based on the information you provided:**

### **Factor 1**

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

### **Factor 2**

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

### **Factor 3**

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

### **Factor 4**

Your consideration of the effect or potential effect on the

market after your use of the copyrighted work weighs: *in favor of fair use*

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Name: Diane Folz

Description of item under review for fair use: Folz thesis Fig. 2.15: Figure 8: The Michelson Interferometer [12], Physics Department, University of Twente, <http://physics.schooltool.nl/irspectroscopy/method.php>, accessed May 2011.

Report generated on: 09-04-2011 at : 08:22:09

## **Based on the information you provided:**

### **Factor 1**

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

### **Factor 2**

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

### **Factor 3**

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

### **Factor 4**

Your consideration of the effect or potential effect on the

market after your use of the copyrighted work weighs: *in favor of fair use*

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## **Virginia Tech ETD Fair Use Analysis Results**

*This is not a replacement for professional legal advice but an effort to assist you in making a sound decision.*

Name: Diane Folz

Description of item under review for fair use: Folz thesis Fig. 2.16: Figure 2.8: An illustration of how an interferogram is Fourier transformed to generate a single beam infrared spectrum. from, FUNDAMENTALS OF FOURIER TRANSFORM INFRARED SPECTROSCOPY, B.C. Smith, CRC Press, New York, NY, 1996, p. 25.

Report generated on: 09-04-2011 at : 08:25:00

### **Based on the information you provided:**

#### **Factor 1**

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

#### **Factor 2**

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

#### **Factor 3**

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

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Name: Diane Folz

Description of item under review for fair use: Folz thesis Fig. 2.2: Figure 2: Interaction of microwaves with materials. from: "Microwave Processing of Ceramic Materials," W.H. Sutton, Ceramic Bulletin, American Ceramic Society, February 1989, p. 377

Report generated on: 09-04-2011 at : 06:57:14

### Based on the information you provided:

#### Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

#### Factor 2

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

#### Factor 3

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#### Factor 4

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Name: Diane Folz

Description of item under review for fair use: Folz thesis Fig. 2.3: Fig. 3.7: Distribution of the electric field in a TE103 cavity, the primary cavity used in this study. from, STRUCTURAL EVOLUTION OF SILICA AEROGEL UNDER A MICROWAVE FIELD, C.E. Folgar, ETD database, Virginia Polytechnic Institute and State University, May 2010, p. 51

Report generated on: 09-04-2011 at : 07:02:51

### **Based on the information you provided:**

#### **Factor 1**

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

#### **Factor 2**

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

#### **Factor 3**

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

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Name: Diane Folz

Description of item under review for fair use: Folz thesis Fig. 2.4: Figure 5.29: Measured power at the output of the coaxial probe at 2.4414GHz. from, UNDERSTANDING MICROWAVE HEATING CAVITIES, Chan and Reader, Artech House, Inc., Norwood, MA, 2000, p. 113

Report generated on: 09-04-2011 at : 07:07:25

## **Based on the information you provided:**

### **Factor 1**

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

### **Factor 2**

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

### **Factor 3**

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Name: Diane Folz

Description of item under review for fair use: Folz thesis Fig. 2.5: Figure 4.4: Output coupling of a magnetron. from, MICROWAVES: INDUSTRIAL, SCIENTIFIC AND MEDICAL APPLICATIONS, J. Thuery, Artech House, Inc. Norwood, MA, 1992, p. 122.

Report generated on: 09-04-2011 at : 07:11:16

### **Based on the information you provided:**

#### **Factor 1**

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

#### **Factor 2**

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

#### **Factor 3**

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

#### **Factor 4**

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Name: Diane Folz

Description of item under review for fair use: Folz thesis Fig. 2.6: Figure 4.9: Schematic of a cross section of a helical TWT. from, MICROWAVES: INDUSTRIAL, SCIENTIFIC AND MEDICAL APPLICATIONS, J. Thuery, Artech House, Inc. Norwood, MA, 1992, p. 127.

Report generated on: 09-04-2011 at : 07:12:58

## **Based on the information you provided:**

### **Factor 1**

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

### **Factor 2**

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

### **Factor 3**

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

### **Factor 4**

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market after your use of the copyrighted work weighs: *in favor of fair use*

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Name: Diane Folz

Description of item under review for fair use: Folz thesis Fig. 2.7: Figure 4.9: Schematic of a cross section of a helical TWT. from, Microwave Fundamentals, VFM and Materials Heating, a PowerPoint presentation by Lambda Technologies, Inc., [www.microcure.com](http://www.microcure.com), p. 26 and 29.

Report generated on: 09-04-2011 at : 07:23:37

### **Based on the information you provided:**

#### **Factor 1**

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

#### **Factor 2**

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

#### **Factor 3**

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Name: Diane Folz

Description of item under review for fair use: Folz thesis Fig. 2.8: Figure on page 4, STA 449 F3 Jupiter Simultaneous TGA-DSC Product Brochure, [www.netzsch.com](http://www.netzsch.com), accessed April 2011.

Report generated on: 09-04-2011 at : 07:32:12

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#### Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

#### Factor 2

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

#### Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

#### Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: *in*

*favor of fair use*

**Based on the information you provided, your use of the copyrighted work weighs: *in favor of fair use***



## RE: Thesis Photos

LeeAnn Ellis

To:

M

[Diane Folz](#)

Monday, September 05, 2011 9:29 AM

You replied on 9/5/2011 10:42 AM.

Of course!

LA

**From:** Diane Folz

**Sent:** Monday, September 05, 2011 9:29 AM

**To:** LeeAnn Ellis

**Cc:** Diane Folz

**Subject:** Thesis Photos

To: LeeAnn Ellis

From: Diane Folz

May I please use the photos you took for me for my thesis? They are  
Figure 3.6: Photograph of the Avatar 330 Smart SpeculATR - ZnSe HATR crystal used to perform HATR-FTIR measurements

and

Figure 3.7: Perkin Elmer FTIR specular reflectance stage with manual adjustments required for focusing the IR beam, circa 1970s.