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Thomason, J.L. (2007) *Composites and the industry/university interface.* In: Composite Materials for Aerospace, Defence and Security Applications, 2007-12-05, Glasgow.

Jim Thomason - Background

University of Strathclyde

- **2007 - Professor of Advanced Materials & Composites, Univ. Strathclyde**
- **2003 - Visiting Professor, Univ. Sheffield, Dept. Eng Materials**

- **1996-2006 Owens Corning Science & Technology, USA & Belgium**
  - New Product development and fundamental research – composites & fibres.
  - Chair of 2004 Gordon Research Conference on Composites
- **1983-96 Shell Research, Amsterdam,**
  - Exploratory Research & Product Development –Polymers , Composites, Interfaces

- **1982-3 Mainz, Germany, Postdoc - polymer blends**
- **1981 Strathclyde PhD – Interphase in multiphase polymers.**
- **1977 Edinburgh BSc – Physics,**

Jim Thomason - Research Interests

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- Interfaces in High Performance Composites
- Natural fibre reinforced polymer composites
- Structure-Processing-Performance in Fibre Reinforced Thermoplastics
- Reinforcements - surface and microstructure
- Application of Molecular Modeling to Materials

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Making the University-Industry (Composite) Interface Work

Jim Thomason

Content

- Introduction
  - Does the materials industry support fundamental research ?
- Getting Support from Industry (an example)
- Results
  - Were we successful ?
- Conclusions -
  - What have we learned ?

Does the materials industry support fundamental research ?

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- It Depends
  - Which Company ?
  - Who are you talking with ?
- In General
  - Product cycle times are becoming shorter
  - Financial considerations are becoming more influential
- Therefore – fundamental research is becoming more difficult to justify within the current business climate

Does the materials industry support fundamental research ?

- However – at the same time
  - Customers demand more (productivity & performance)
  - Many (composite) products are high on the S-curve of the development cycle = less improvement for more effort
- One solution is to innovate more
  - Innovation by serendipity
  - New knowledge based Innovation
- Therefore – more fundamental insights are required

Product development & fundamental research

- Industry may support fundamental work which:
  - Reduces cost, time and waste to manufacture an existing product
  - Reduces cost and time to develop a new product
  - Improves quality
- Industry is less likely to support fundamental work which
  - Results in incremental performance improvements

Industrial Support for University Research Programmes

An example of how to get some support

How Does OC make (*more*) Money ???

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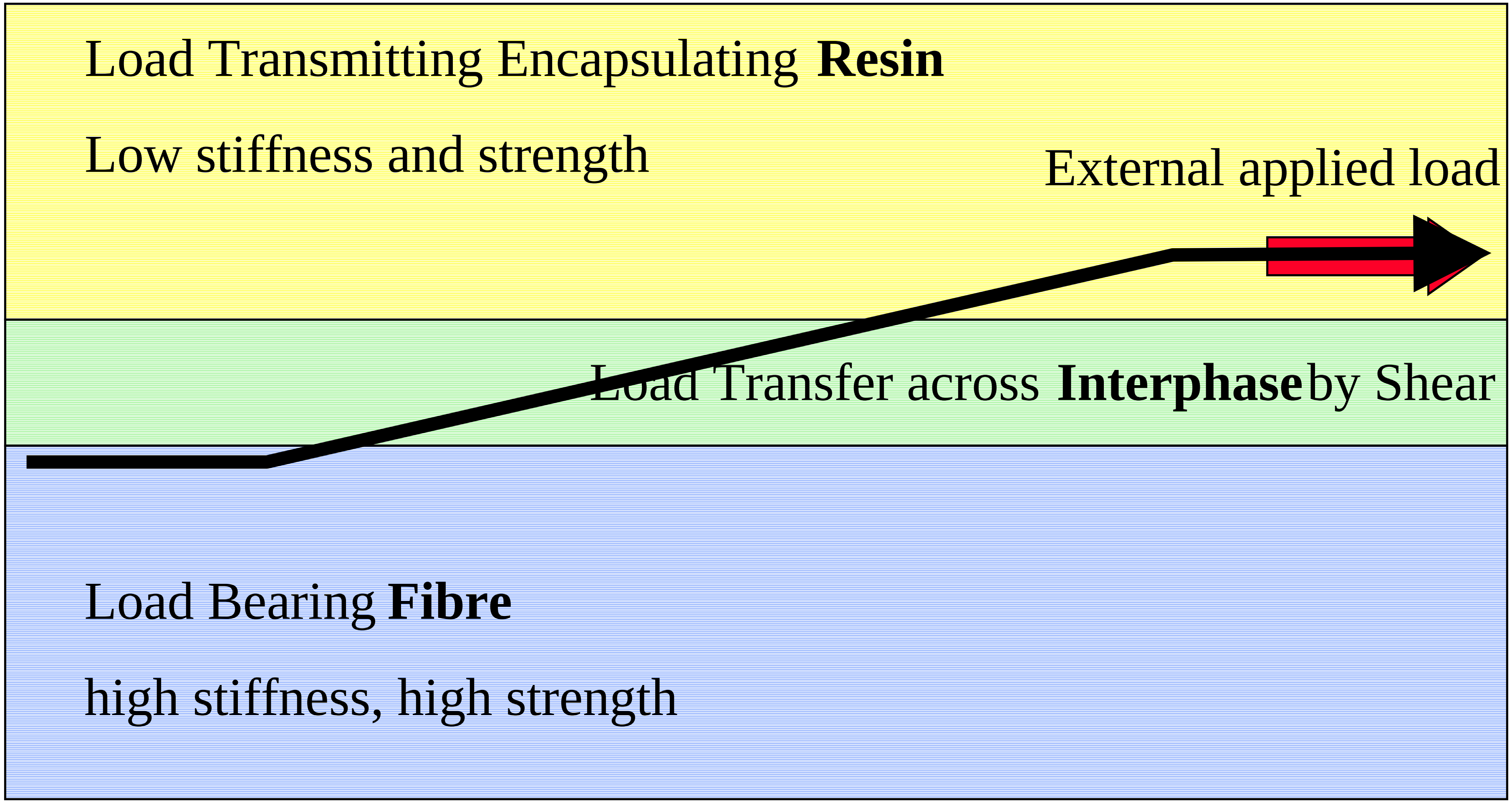
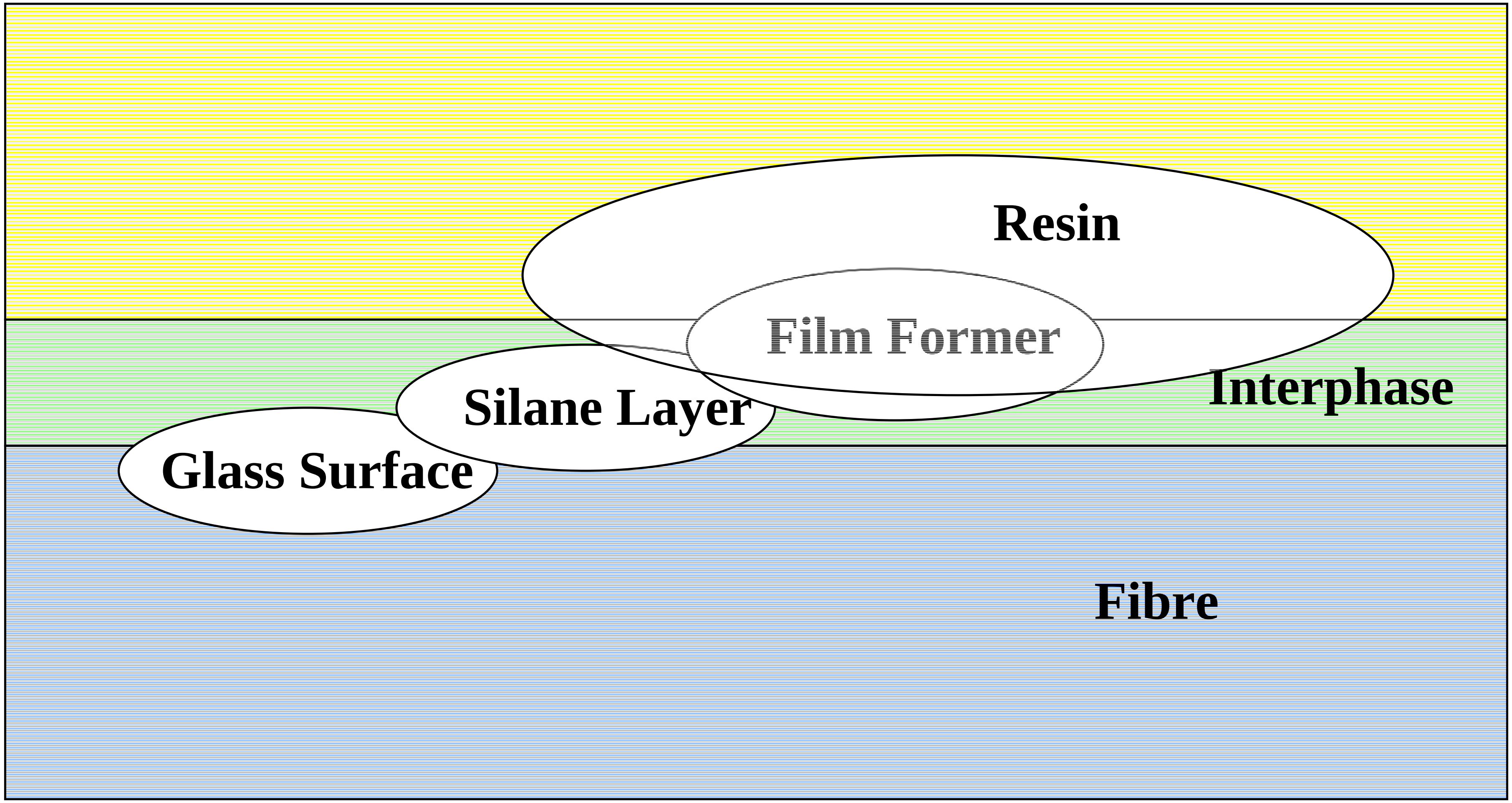
- You sell (*more*) reinforcements for composite materials
- So you need to produce good (*better*) reinforcement products
- So you need to understand (*better*) what reinforcements do (*for your customers*)
- So how does fibre reinforcement work ???

How does fibre reinforcement work ?



A "good" interphase is critical to nearly all composite performance criteria

What do we need to understand (better) ?



New Insights → New Product Innovations

The Results

- **Were we successful ?**
  - **Owens Corning supports**
    - ***PhD Project 1 - X.Liu 10/2003-9/2006***
    - ***PhD Project 2 - C. Wang 10/2005-9/2008***
    - ***Post Doc Project - X. Liu 10/2006-9/2007***

Conclusions - What have we learned ?

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- **Academia**
  - *Be flexible on IP*
  - *Plan for some changes in direction (in a 3 year project)*
  - *Clear unambiguous results (with confidence limits)*
- **Industry**
  - *Be flexible on publications*
  - *Ensure the research results will still be relevant in 3 years*
  - *Be (reasonably) patient*
- **Communication is key**
  - *Frequent*
  - *Appropriate Level of Detail*

Composites Knowledge Resource

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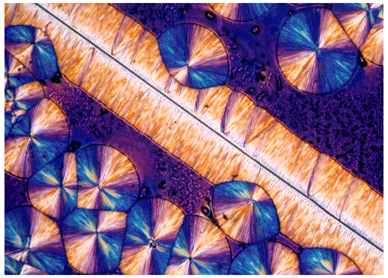
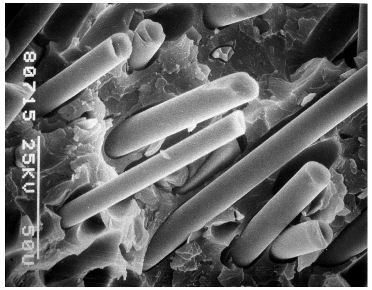
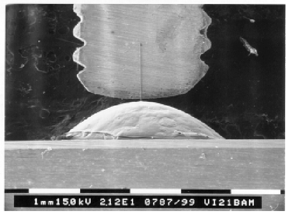
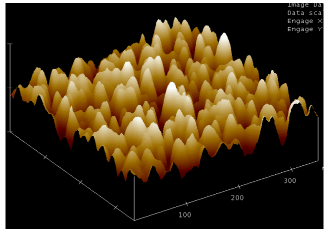


Thermoplastic Composites Structure-Process-Performance

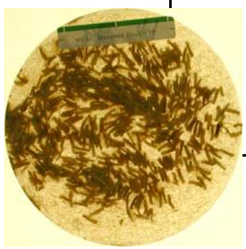


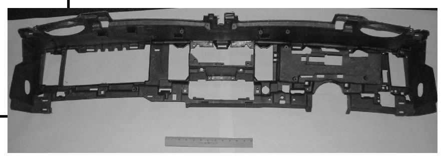


Surface & Interface Micromechanics

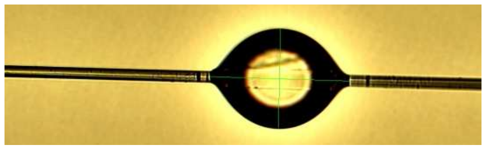


Composites based on Sustainable Materials





Composites for Wind Energy



The Challenge of New Product Development

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- **Results! Why, man, I have gotten a lot of results. I know several thousand things that won't work.**
  - **Thomas A. Edison (1847 - 1931)**

- **Industry can no longer afford to waste resources doing it this way**

- **Need better understanding and insights to guide more efficient product development programs with higher probability of success**

XPS data - 2 Spectrometers

1% APS coated Advantex fibres (Daresbury)

As coated

TOA	C	Si	O	Ca	Al	Mg	Na	N	C/Si	C/N	Si/N	O/Si
25	23.9	20.9	45.9	3.0	3.9	0.0	0.0	2.4	1.1	9.9	8.7	2.2
45	15.2	21.4	53.6	4.2	4.1	0.0	0.0	1.5	0.7	10.1	14.3	2.5
90	9.6	21.1	58.6	5.3	4.5	0.0	0.0	0.9	0.5	10.7	23.4	2.8

WWE

TOA	C	Si	O	Ca	Al	Mg	Na	N	C/Si	C/N	Si/N	O/Si
25	24.9	18.8	46.9	3.3	4.5	0.0	0.0	1.6	1.3	15.6	11.8	2.5
45	17.1	19.2	53.3	4.3	5.4	0.0	0.0	0.7	0.9	24.4	27.4	2.8
90	8.4	20.1	59.9	5.3	5.6	0.0	0.0	0.7	0.4	12.0	28.7	3.0

HWE

TOA	C	Si	O	Ca	Al	Mg	Na	N	C/Si	C/N	Si/N	O/Si
25	26.3	20.0	43.4	3.1	5.4	0.0	0.0	1.8	1.32	14.6	11.1	2.2
45	21.5	18.9	50.8	3.7	4.3	0.0	0.0	0.8	1.14	26.9	23.6	2.7
90	9.9	19.3	59.1	5.2	5.8	0.0	0.0	0.7	0.51	14.1	27.6	3.1

1% APS coated E-glass fibres (Daresbury)

As coated

TOA	C	Si	O	Ca	Al	Mg	Na	N	B	C/Si	C/N	Si/N	O/Si
25	30.9	17.4	39.0	2.3	3.3	1.0	0.0	3.6	2.5	1.8	8.6	4.8	2.2
45	19.7	17.6	48.5	3.5	4.8	0.6	0.0	2.4	2.9	1.1	8.2	7.3	2.8
90	19.4	17.0	50.4	3.6	4.5	1.2	0.0	1.7	2.2	1.1	11.4	10.0	3.0

WWE

TOA	C	Si	O	Ca	Al	Mg	Na	N	B	C/Si	C/N	Si/N	O/Si
25	33.9	15.1	41.5	2.1	3.3	0.0	0.0	2.5	1.6	2.2	13.6	6.0	2.7
45	24.4	16.0	47.2	3.5	4.5	1.2	0.0	1.4	1.8	1.5	17.4	11.4	3.0
90	12.5	17.7	54.4	4.0	5.6	1.1	0.0	1.1	3.6	0.7	11.4	16.1	3.1

HWE

TOA	C	Si	O	Ca	Al	Mg	Na	N	B	C/Si	C/N	Si/N	O/Si
25	17.2	18.5	50.6	2.6	5.7	1.4	0.0	2.3	1.7	0.9	7.5	8.0	2.7
45	12.5	18.9	55.3	3.4	5.7	0.9	0.0	1.0	2.3	0.7	12.5	18.9	2.9
90	7.6	18.4	60.6	3.8	5.5	0.9	0.0	0.8	2.4	0.4	9.5	23.0	3.3

1% APS coated Advantex fibres (Sheffield)

As coated

TOA	C	Si	O	Ca	Al	Mg	Na	N	C/Si	C/N	Si/N	O/Si
25	24.8	19.2	46.1	2.8	3.8	0.4	0.3	2.8	1.3	9.2	7.1	2.4
45	20.0	19.4	50.3	3.4	4.0	0.0	0.6	2.5	1.0	8.2	7.9	2.6
90	16.3	18.1	54.4	3.9	3.9	0.7	0.6	2.3	0.9	7.1	7.9	3.0

WWE

TOA	C	Si	O	Ca	Al	Mg	Na	N	C/Si	C/N	Si/N	O/Si
25	26.1	18.2	46.1	2.8	4.7	0.0	0.0	2.2	1.4	11.9	8.3	2.5
45	20.2	18.9	50.7	3.3	4.3	0.8	0.2	1.9	1.1	10.9	10.2	2.7
90	17.0	17.8	53.6	3.8	4.7	1.0	0.3	2.0	1.0	8.7	9.2	3.0

HWE

TOA	C	Si	O	Ca	Al	Mg	Na	N	C/Si	C/N	Si/N	O/Si
25	22.2	19.3	48.7	2.9	4.6	0.0	0.0	2.5	1.1	9.1	7.9	2.5
45	17.4	18.7	52.8	3.3	4.9	0.8	0.0	2.3	0.9	7.8	8.4	2.8
90	14.9	17.9	56.1	4.0	4.3	0.7	0.2	2.0	0.8	7.5	9.0	3.1

1% APS coated E-glass fibres (Sheffield)

As coated

TOA	C	Si	O	Ca	Al	Mg	Na	N	B	C/Si	C/N	Si/N	O/Si
25	23.0	17.7	47.2	2.3	4.2	0.3	0.0	3.3	2.2	1.3	7.0	5.4	2.7
45	17.1	17.3	51.4	2.8	4.9	1.1	0.2	2.7	2.8	1.0	6.5	6.5	3.0
90	14.2	16.4	55.9	3.3	4.7	1.1	0.4	2.1	2.2	0.9	6.9	8.0	3.4

WWE

TOA	C	Si	O	Ca	Al	Mg	Na	N	B	C/Si	C/N	Si/N	O/Si
25	28.3	16.9	44.2	2.0	5.4	0.6	0.0	2.8	0.0	1.7	10.4	6.2	2.6
45	22.4	16.1	48.4	2.4	5.4	0.9	0.0	2.6	2.0	1.4	8.8	6.3	3.0
90	19.6	15.7	51.9	2.8	4.7	1.1	0.0	2.4	2.1	1.2	8.3	6.7	3.3

HWE

TOA	C	Si	O	Ca	Al	Mg	Na	N	B	C/Si	C/N	Si/N	O/Si
25	24.3	16.4	46.7	2.3	5.5	1.0	0.0	2.7	1.4	1.5	9.1	6.2	2.9
45	20.4	16.6	50.8	2.7	5.0	1.1	0.0	2.4	1.1	1.2	8.9	7.2	3.1
90	18.1	15.8	53.4	3.0	4.8	0.9	0.0	2.1	2.2	1.1	8.8	7.8	3.4

Contact Angle, water on glass slides

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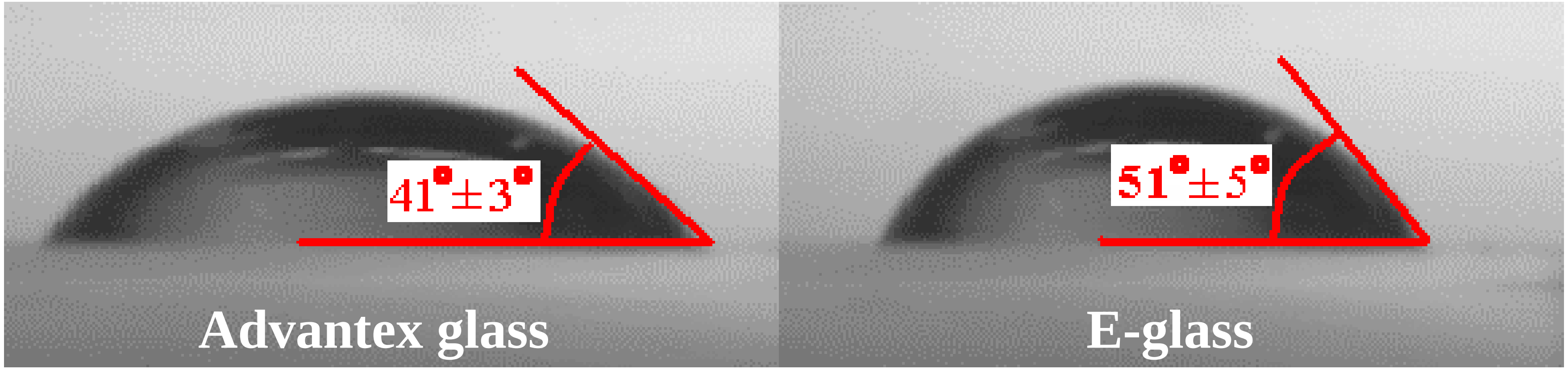

- Advantex is more hydrophilic than E-glass.
- Glass surface chemistry is different.
- Advantex surface had more polar (hydroxyl) groups than E-glass.

<u>Why is this important ???</u>

-OH groups are the principal sites for adsorption of, and reaction with, water and sizing molecules