Design and Manufacturing Research for a
Lean World Workshop

Analytical Models as Design Tools for Electronics Cooling Applications

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Outline

- Web-based and spreadsheet design tools based on analytical analyses

- Physically-based, minimal input, meaningful output

- Web tools: *www.mhtlab.uwaterloo.ca\tools.html*

- Spreadsheet tools: *rix@mhtlab.uwaterloo.ca*

Thermophysical Properties of Liquids & Gases

- Function of temperature
- Gases: air, argon, nitrogen, carbon dioxide

- Liquids: water, ethylene glycol, mixtures

MHTL--Online Calculations - Microsoft Internet Explorer

File   Edit   View   Favorites   Tools   Help

online tools

Fluid Properties Calculator

Input Values	
Fluid:	Ethylene Glycol 30%
Temperature:	20 (degrees C)
Digits:	5

Calculate

Results		
Density:	1.0376E+3	(kg/m^3)
Dynamic Viscosity:	2.1671E-3	(kg/m.s)
Kinematic Viscosity:	2.0885E-6	(m^2/s)
Specific Heat:	3.7141E+3	(J/kg.K)
Conductivity:	0.48418	(W/m.K)
Prandtl number:	16.623	
Thermal Diffusivity:	1.2564E-7	(m^2/s)

Natural Convection Models for Heat Sinks

- Plate fin and radial fin configurations
- Solves for source temperature or heat flow rate

Effective Conductivity of Multilayered Substrates

- Effective conductivity calculator based on Fourier series analysis
- Up to 20 layers, pre-programmed material properties available
- Calculated k effective based on relative source size, position and edge conditions

Spreading Resistance Calculators

- **Circular and rectangular substrates**
  - Single and two layers
  - Finite, semi-infite (flux tube) and infinite
- **Circular, strip and rectangular sources**
  - Isoflux
  - Parabolic
  - Equivalent Isothermal
- **Edge cooling calculators are available**
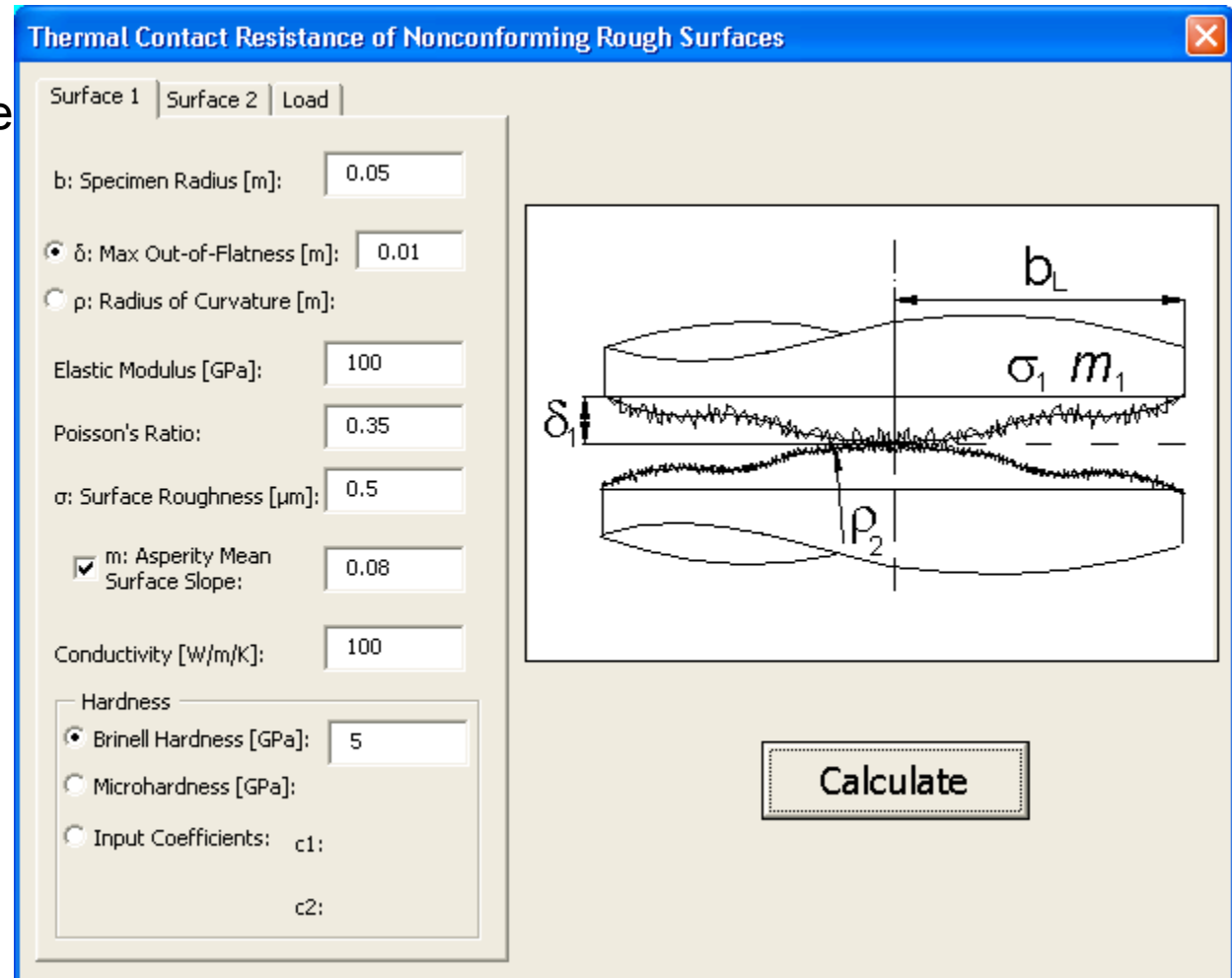
Thermal Contact Resistance for Non-conforming Rough Surfaces

- Excel - VBA implementation of analytical model
- Calculation based on readily available surface parameters, such as
  - ✓ surface slope
  - ✓ hardness
  - ✓ out-of- flatness