Polymer Troubleshooting Guide
Polymer problems identified – simply, efficiently

Ensure raw materials, masterbatches and finished products meet your quality standards, and if not, investigate why using Thermo Scientific™ Spectroscopy Solutions.

- Thermo Scientific™ Nicolet™ Summit FTIR Spectrometer
- Thermo Scientific™ Nicolet™ iS20 FTIR Spectrometer
- Thermo Scientific™ Nicolet™ iS50 FTIR Spectrometer
- Thermo Scientific™ Everest™ Diamond ATR Accessory
- Thermo Scientific™ SMART™ iTX Diamond ATR Accessory
- Thermo Scientific™ OMNIC™ Specta™ Software
- Thermo Scientific™ OMNIC™ Paradigm Software
- Thermo Scientific™ DXR2 Raman Microscope
- Thermo Scientific™ Nicolet™ iN10 Infrared Microscope
- Thermo Scientific™ Nicolet™ iS50 Modules and Accessories
### Plastic or Polymer Problems?

Use the Thermo Scientific Polymer Troubleshooting Guide to find answers.

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<th>POSSIBLE CAUSES</th>
<th>SAMPLE TESTING PLAN</th>
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<th>RECOMMENDED CONFIGURATION</th>
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</table>
| **Bloom** | Improper additive formulation – excess or un-reacted additive | 1. Scrape material from surface 2. Measure by single-bounce ATR | 1. Search libraries to identify the unknown material 2. Adjust formulation based on identified material | **Nicolet iS20 FTIR Spectrometer**  
**Smart iTX Diamond ATR Accessory**  
**OMNIC Specta Software for Polymer Labs** |
| **Hazing/streaking/incorrect color (white or black)** | Improper formulation: additives or fillers; contamination, poor mixing | 1. Measure directly or excise outer or inner material from sample 2. Measure using diamond ATR Mid-IR or Far-IR for inorganic fillers | 1. Compare to reference part data and search libraries to identify differences 2. Change formulation if appropriate | **Nicolet iS50 FTIR Spectrometer**  
**Built-In Diamond ATR Accessory**  
**Solid-substrate beamsplitter**  
**OMNIC Specta Software for Polymer Labs** |
| **Oily or tacky surface** | Improper additive formulation or contamination | 1. Wipe or scrape surface to isolate material or direct analysis 2. Measure residue or sample surface on single-bounce ATR 3. Measure reference part or sample with surface cut off | 1. Search libraries to identify material 2. Adjust formulation or change process to avoid contamination | **Nicolet Summit FTIR Spectrometer**  
**Everest Diamond ATR Accessory**  
**OMNIC Paradigm Software with Polymer Library** |
| **Inclusions, de-lamination, fish eyes (complex)** | Poor processing, contamination | 1. Isolation of included contaminants 2. Sample cross-sectioning to view layers 3. Perform microscopic analysis: a. FTR: 25 µm b. Dispersive Raman: 5 µm | 1. Search libraries to identify contamination 2. Change process to avoid contamination | **Nicolet iN10 FTIR Microscope**  
**OMNIC Specta Software for Polymer Labs**  
**OR**  
**DXR2 Raman Microscope**  
**OMNIC Specta Software for Raman Analytical** |
| **Roughness, speckles, mars, bubbles** | Contamination: surface or embedded processing problem (trapped gas) | 1. Isolate surface or embedded material 2. Measure using single-bounce Diamond, ZnSe or Ge* ATR | 1. Search libraries to identify contamination 2. Change process to avoid contamination | **Nicolet iS20 FTIR Spectrometer**  
**Smart iTX Diamond ATR Accessory**  
**OMNIC Specta Software for Polymer Labs** |
| **Brittle, cracking, weakness** | Oxidation, degradation, contaminant, incorrect material | 1. Excise surface or inner material 2. Measure by single-bounce ATR | 1. Compare to reference part 2. Identify unexpected components 3. Ensure material is correct for conditions; change formulation as needed | **Nicolet iS20 FTIR Spectrometer**  
**Smart iTX Diamond ATR Accessory**  
**OMNIC Specta Software for Polymer Labs** |
| **Diminished physical properties** | Crystallinity, structure, polymorphism, inorganic additives, degradation, contamination | Measure directly using Raman or single-bounce Diamond ATR in Far-IR range | 1. Search libraries using spectral region search to identify components 2. Optimize formulation or manufacturing process | **Nicolet iS50 FTIR Spectrometer**  
**Nicolet iS50 Raman Module**  
**Built-In Diamond ATR Accessory**  
**Solid-substrate beamsplitter** |
| **Material too soft or hard** | Improper formulation: co-polymers, plasticizers, fillers (>1% by weight) | 1. Measure directly using single-bounce Diamond, ZnSe or Ge* ATR 2. May require cutting away top surface to expose interior | 1. Calculate peak height or area ratio 2. Verify co-polymer ratios 3. Adjust formulation and check ratios routinely | **Nicolet Summit FTIR Spectrometer**  
**Everest Diamond ATR Accessory**  
**OMNIC Paradigm Software with Polymer Library** |
| | Improper formulation: low-level additives (<1% by weight) | 1. Melt polymer into thin film of known thickness 2. Measure film with transmission | 1. Quantify additives using peak height or area method 2. Adjust formulation 3. Check additives routinely | **Nicolet Summit FTIR Spectrometer**  
**Mini-Film Maker Kit** |
| **Swelling** | Surface contamination | 1. Extract contamination into solvent 2. Dry onto ATR crystal or IR window 3. Measure using transmission | 1. Search libraries to identify contamination 2. Determine if polymer or formulation is appropriate for application | **Nicolet Summit FTIR Spectrometer**  
**Everest Diamond ATR Accessory**  
**OMNIC Paradigm Software with Polymer Library** |
| **Warping** | Improper formulation, incorrect processing conditions (if nothing found wrong with formulation) | 1. Measure directly using single-bounce Diamond, ZnSe or Ge* ATR 2. May require cutting away top surface to expose interior | 1. Calculate peak height or area ratio 2. Verify co-polymer ratios 3. Adjust formulation and check ratios routinely | **Nicolet iS20 FTIR Spectrometer**  
**Smart iTX Diamond ATR Accessory**  
**OMNIC Specta Software for Polymer Labs** |
| **Wear, premature failure** | Wrong material or formulation, material failure, extreme use conditions | 1. Measure directly using single-bounce Diamond, ZnSe or Ge* ATR 2. May require cutting away top surface to expose interior 3. Measure sample and reference part on TGA-IR | 1. Search libraries to identify material 2. Compare sample data to reference part data to identify differences 3. Change formulation if appropriate | **Nicolet iS50 FTIR Spectrometer**  
**Built-In Diamond ATR Accessory**  
**TGA Interface Module**  
**OMNIC Specta Vapor Phase library** |
| **Odor** | Oxidation, degradation, contamination | 1. Solvent extraction, evaporate solvent 2. Measure residue on ATR or IR window 3. Measure sample and reference part on TGA-IR | 1. Search libraries to identify material or contamination 2. Compare sample data to reference part data to identify differences 3. Change formulation if appropriate | **Nicolet iS20 FTIR Spectrometer**  
**TGA Interface Module**  
**OMNIC Specta Vapor Phase library** |
| **Need to verify raw materials** | Inconsistent or out-of-specification bulk ingredients (>1% by weight) | 1. Measure directly using single-bounce ATR OR 2. Measure polymer beads on NIR integrating sphere Sample Spinner or powders in container by NIR Fiber Probe | 1. Use QCheck function to correlate spectrum with reference material OR 2. Use chemometrics model to identify and quantify ingredients 3. Apply statistical process control to ensure product consistency | **Nicolet Summit FTIR Spectrometer**  
**Everest Diamond ATR Accessory**  
**Nicolet iS50 FTIR Spectrometer**  
**Nicolet iS50 NIR Module** |
| | Inconsistent or out-of-specification low-level ingredients (<1% by weight) | 1. Melt polymer into thin film of known thickness 2. Measure film with transmission | 1. Quantify additives using peak height or area method 2. Apply statistical process control to ensure product consistency | **Nicolet Summit FTIR Spectrometer**  
**Mini-Film Maker Kit** |

* Ge for Carbon-filled polymers  
• TGA-IR = Thermogravimetric Analysis Infrared  
• NIR = Near infrared  
• FTIR = Fourier transform infrared  
• ATR = Attenuated total reflectance

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**Watch how-to videos and download application notes from our Polymer Resource Center at** [thermofisher.com/polymers](http://thermofisher.com/polymers)
# Product Selection Guide

Spectroscopy Solution by Task and Sample Property

Using the table below, find your task and sample feature to select the instrument configuration and solve your polymer problems.

## Thermo Scientific Instruments

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<th>Task</th>
<th>QA/QC Verification</th>
<th>Material Characterization</th>
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<tr>
<td>• Incoming ingredients</td>
<td>• Additive concentrations (plasticizers, colorants, masterbatch)</td>
<td>• New product development</td>
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<td>• In-process materials</td>
<td></td>
<td>• Failure analysis</td>
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<tr>
<td>• Finished products</td>
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<td>• Deformation studies</td>
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<td>• Pellet composition</td>
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<td>• Reverse engineering</td>
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<table>
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<tr>
<th>Property</th>
<th>Component Concentration &gt;1%</th>
<th>Component Concentration &lt;1%</th>
<th>Bulk</th>
<th>Physical/Chemical Formulation</th>
<th>Fillers, Inorganic Pigments</th>
<th>Crystallinity, Morphology</th>
<th>Multi-layer Films, Small Inclusions</th>
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<td>Nicolet Summit FTIR Spectrometer</td>
<td>Everest Diamond ATR* Accessory</td>
<td>Hot-pressed Film Kit</td>
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</tr>
<tr>
<td>Nicolet iS20 FTIR Spectrometer</td>
<td>Smart iTX ATR Accessory</td>
<td>Hot-pressed Film Kit</td>
<td>Smart NIR Integrating Sphere</td>
<td>In-compartment TGA accessory + Mercury TGA Software</td>
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<tr>
<td>Nicolet iS50 FTIR Spectrometer</td>
<td>Built-in Diamond ATR* or Smart iTX ATR Accessory</td>
<td>Hot-pressed Film Kit</td>
<td>iS50 NIR Module</td>
<td>TGA-IR accessory + Mercury TGA Software</td>
<td>Built-in Diamond ATR + Solid Substrate beamsplitter</td>
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<tr>
<td>Nicolet iN10 Microscope</td>
<td>Micro Tip ATR* accessory</td>
<td>Hot-pressed Film Kit</td>
<td>Nicolet iZ10 Module + In-compartment TGA accessory + Mercury TGA Software</td>
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<td></td>
<td>Nicolet iN10 Infrared Microscope</td>
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<tr>
<td>DXR2 Raman Microscope</td>
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* ATR is a useful tool for quick, basic material and additives characterization

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## Polymer Analysis Kits

We offer kits that combine commonly used tools for polymer analysis. They include our patented Multi-Component Search, a 13,000 compound spectral library and 240-page Infrared Spectroscopy of Polymers Knowledgebase along with appropriate sampling device(s). For more details, see the FTIR Polymer Analysis Kit flyer (FL52273_E).

### Polymer Analysis Kits

- **Nicolet Summit FTIR Spectrometer with Everest ATR Accessory**
  - For streamlined QA/QC testing of polymers and ingredients

- **Nicolet iS20 FTIR Spectrometer with iTX ATR Accessory**
  - For high-performance polymer QA/QC and contaminant/failure analysis

- **Nicolet iS50 FTIR Spectrometer with TGA-IR accessory**
  - For polymer method development, deformation, troubleshooting and research

- **DXR2 Raman Microscope or Nicolet iN10 Microscope**
  - For small particle identification and polymer characterization that requires high-spatial resolution

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Visit our Polymer Resource Center to learn more at: [thermofisher.com/polymers](https://thermofisher.com/polymers)

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