

# polymer problems identified



**simply, efficiently**

Ensure raw materials, intermediates or finished products comply with your quality standards with Thermo Scientific™ Spectroscopy Solutions.

Nicolet™ iS™5 FT-IR spectrometer  
Nicolet iS50 FT-IR spectrometer  
Nicolet iS10 FT-IR spectrometer

SMART™ iTR Diamond ATR accessory  
OMNIC™ Specta™ software packages  
DXR™ Raman microscope

Nicolet iN™10 IR microscope  
Nicolet iS50 modules and accessories

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# Plastic or Polymer Problems?

Use the Thermo Scientific Polymer Troubleshooting Guide to find Answers.



1.

Find your polymer problem
2.

Learn how to analyze the problem
3.

Select spectroscopy solutions to help your analysis

SYMPTOM <i>What's your problem; what do you observe?</i>	POSSIBLE CAUSES <i>What could cause this problem?</i>	SAMPLE TESTING PLAN <i>How do you measure?</i>	DATA ANALYSIS PLAN <i>How do you identify the problem?</i>	RECOMMENDED CONFIGURATION <i>What to use?</i>
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	<ul style="list-style-type: none"><li>Nicolet iS10 FT-IR spectrometer</li><li>Smart iTR Diamond ATR accessory</li><li>OMNIC Spectra software for Polymer Labs</li></ul>
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	<ul style="list-style-type: none"><li>Nicolet iS50 FT-IR spectrometer</li><li>Built-in Diamond ATR accessory</li><li>Solid-substrate beamsplitter</li><li>OMNIC Spectra software for Polymer Labs</li></ul>
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	<ul style="list-style-type: none"><li>Nicolet iS5 FT-IR spectrometer</li><li>iD5 Diamond ATR accessory</li><li>OMNIC Spectra software for Polymer Labs</li></ul>
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. FT-IR: ≥5 μm b. Dispersive Raman: ≥1 μm	1. Search libraries to identify contamination 2. Change process to avoid contamination	<ul style="list-style-type: none"><li>Nicolet iN10 FT-IR microscope</li><li>OMNIC Spectra software for Polymer Labs</li></ul> OR <ul style="list-style-type: none"><li>DXR Raman microscope</li><li>OMNIC Spectra software for Raman Analytical</li></ul>
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	<ul style="list-style-type: none"><li>Nicolet iS10 FT-IR spectrometer</li><li>Smart iTR Diamond ATR accessory</li><li>OMNIC Spectra software for Polymer Labs</li></ul>
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	<ul style="list-style-type: none"><li>Nicolet iS10 FT-IR spectrometer</li><li>Smart iTR Diamond ATR accessory</li><li>OMNIC Spectra software for Polymer Labs</li></ul>
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	<ul style="list-style-type: none"><li>Nicolet iS50 FT-IR spectrometer</li><li>iS50 Raman module</li><li>Built-in Diamond ATR accessory</li><li>Solid-substrate beamsplitter</li></ul>
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	<ul style="list-style-type: none"><li>Nicolet iS5 FT-IR spectrometer</li><li>iD5 Diamond ATR accessory</li><li>OMNIC Spectra software for Polymer Labs</li></ul>
	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	<ul style="list-style-type: none"><li>Nicolet iS5 FT-IR spectrometer</li><li>Mini-Filmmaker Kit</li></ul>
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	<ul style="list-style-type: none"><li>Nicolet iS5 FT-IR spectrometer</li><li>iD5 Diamond ATR accessory</li><li>OMNIC Spectra software for Polymer Labs</li></ul>
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	<ul style="list-style-type: none"><li>Nicolet iS10 FT-IR spectrometer</li><li>Smart iTR Diamond ATR accessory</li><li>OMNIC Spectra software for Polymer Labs</li></ul>
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	<ul style="list-style-type: none"><li>Nicolet iS50 FT-IR spectrometer</li><li>Built-in Diamond ATR accessory</li><li>TGA Interface module</li><li>OMNIC Spectra Vapor Phase library</li></ul>
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	<ul style="list-style-type: none"><li>Nicolet iS10 FT-IR spectrometer</li><li>TGA Interface module</li><li>OMNIC Spectra Vapor Phase library</li></ul>
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 containers 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	<ul style="list-style-type: none"><li>Nicolet iS5 FT-IR spectrometer</li><li>iD5 Diamond ATR accessory</li></ul> OR <ul style="list-style-type: none"><li>Nicolet iS50 FT-IR spectrometer</li><li>iS50 NIR module</li></ul>
	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	<ul style="list-style-type: none"><li>Nicolet iS5 FT-IR spectrometer</li><li>Mini-Filmmaker Kit</li></ul>

TGA-IR = Thermal Gravimetric Analysis Infrared; NIR = Near infrared; FT-IR = Fourier Transform infrared; ATR = Attenuated total reflectance.

\* Ge for Carbon-filled polymers

Need more help? Talk to a spectroscopy expert by calling 1-800-532-4752. Watch how-to videos and download application notes from our Polymer Resource Center at: [www.thermoscientific.com/polymers](http://www.thermoscientific.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.



### 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 Knowledge Base along with appropriate sampling device(s). For more details, see the FT-IR Polymer Analysis Kit flyer (FL52273\_E).

Thermo Scientific Instruments	Task	QA/QC Verification			Material Characterization			
		<ul style="list-style-type: none"> <li>Incoming ingredients</li> <li>In-process materials</li> <li>Finished products</li> </ul>		<ul style="list-style-type: none"> <li>Pellet composition</li> </ul>	<ul style="list-style-type: none"> <li>New product development</li> <li>Failure analysis</li> <li>Deformation studies</li> <li>Reverse engineering</li> </ul>			
	Property	Component Concentration >1%	Component Concentration <1%	Bulk	Physical/Chemical Formulation	Fillers, Inorganic Pigments	Crystallinity, Morphology	Multi-layer Films, Small Inclusions
Nicolet iS5 FT-IR spectrometer		iD3 ATR* or iD5 ATR* accessory	Hot-pressed Film Kit					
Nicolet iS10 FT-IR spectrometer		Smart iTR* accessory	Hot-pressed Film Kit	Smart NIR Integrating Sphere	In-compartment TGA accessory + Mercury TGA software			
Nicolet iS50 FT-IR spectrometer		Built-in Diamond ATR* or Smart iTR* accessory	Hot-pressed Film Kit	iS50 NIR module	TGA/IR accessory + Mercury TGA software	Built-in Diamond ATR + Solid Substrate beamsplitter	iS50 Raman module	
Nicolet iN10 microscope		Micro Tip ATR* accessory	Hot-pressed Film Kit		Nicolet iZ10 module + In-compartment TGA accessory + Mercury TGA software			Nicolet iN10 Infrared microscope
DXR Raman microscope						DXR Raman microscope	DXR Raman microscope	DXR Raman microscope

\* ATR is a useful tool for basic material characterization



**Thermo Scientific Nicolet iS5 FT-IR spectrometer**  
For high productivity QA/QC of polymers and ingredients



**Thermo Scientific Nicolet iS10 FT-IR spectrometer**  
For high performance, polymer QA/QC and analytical services



**Thermo Scientific Nicolet iS50 FT-IR spectrometer**  
For polymer method development, deformation, troubleshooting and research



**Thermo Scientific DXR Raman microscope or Thermo Scientific Nicolet iN10 microscope**  
For small particle identification or high spatial resolution polymer characterization needs



**Need more help? Talk to a spectroscopy expert by calling 1-800-532-4752. Watch how-to videos and download application notes from our Polymer Resource Center at: [www.thermoscientific.com/polymers](http://www.thermoscientific.com/polymers)**

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PG52464\_E 05/13M

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