Guide

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 X FTIR Spectrometer
- ✓ Thermo Scientific™ Nicolet™ Apex 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™ DXR3 Raman Microscope
- ✓ Thermo Scientific™ Nicolet™ iN10 Infrared Microscope
- ✓ Thermo Scientific™ 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 *What's your problem; what do you observe?*	POSSIBLE CAUSES *What could cause this problem?*	SAMPLE TESTING PLAN *How do you measure?*	DATA ANALYSIS PLAN *How do you identify the problem?*	RECOMMENDED CONFIGURATION *What to use?*
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 Apex 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 X 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. FTIR: ≥5 µm b. Dispersive Raman: ≥1 µm	1. Search libraries to identify contamination 2. Change process to avoid contamination	• Nicolet iN10 FTIR Microscope • OMNIC Specta Software for Polymer Labs OR • DXR3 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 Apex 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 Apex 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 X 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 X 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 X 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 Apex 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 Apex 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 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	• Nicolet Summit X FTIR Spectrometer • Everest Diamond ATR Accessory OR • 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 X 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.

Watch how-to videos and download application notes from our Polymer Resource Center at **thermofisher.com/polymers**

Product Selection Guide

Spectroscopy Solution by Task and Sample Property

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).

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

Thermo Scientific Instruments	Task	QA/QC Verification			Material Characterization			
		• Incoming ingredients • In-process materials • Finished products • Pellet composition • Additive concentrations (plasticizers, colorants, masterbatch)			• New product development • Failure analysis • Deformulation studies • Reverse engineering			
	Property	Component Concentration >1%	Component Concentration <1%	Bulk	Physical/ Chemical Formulation	Fillers, Inorganic Pigments	Crystallinity, Morphology	Multi-layer Films, Small Inclusions
Nicolet Summit X FTIR Spectrometer	Everest Diamond ATR* Accessory		Hot-pressed Film Kit					
Nicolet Apex FTIR Spectrometer	Smart iTX ATR Accessory		Hot-pressed Film Kit	Smart NIR Integrating Sphere	In-compartment TGA accessory + Mercury TGA Software			
Nicolet iS50 FTIR Spectrometer	Built-in Diamond ATR* or Smart iTX ATR 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
DXR3 Raman Microscope						DXR3 Raman Microscope	DXR3 Raman Microscope	DXR3 Raman Microscope

* ATR is a useful tool for quick, basic material and additives characterization

Nicolet Summit X FTIR Spectrometer with Everest ATR Accessory

For streamlined QA/QC testing of polymers and ingredients

Nicolet Apex 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, deformulation, troubleshooting and research

DXR3 Raman Microscope or Nicolet iN10 Microscope

For small particle identification and polymer characterization that requires high-spatial resolution

Visit our Polymer Resource Center to learn more at **thermofisher.com/polymers**