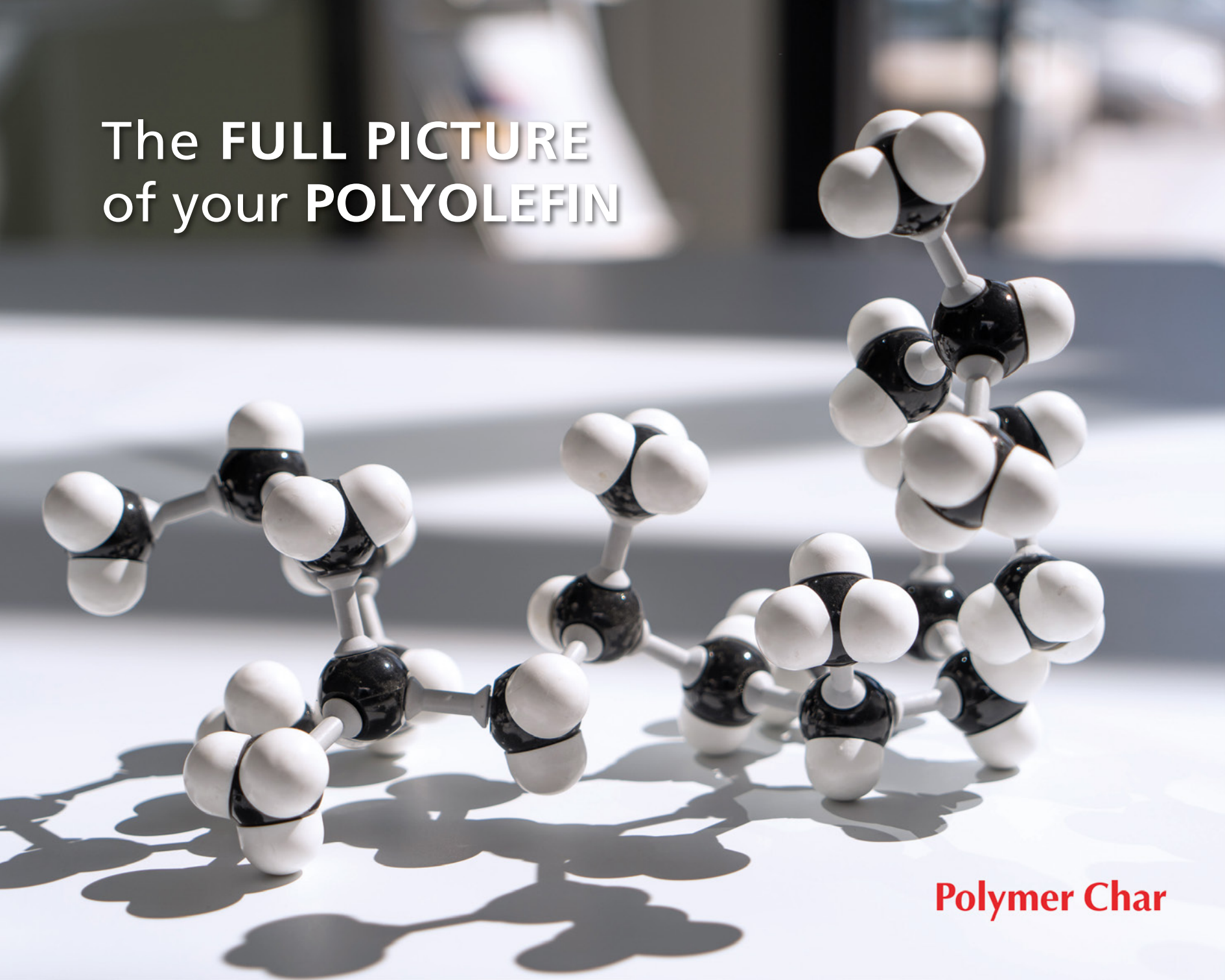

The FULL PICTURE
of your POLYOLEFIN
Polymer Char

Contents

Overview

THE MOST COMPLETE RANGE OF TOOLS FOR POLYOLEFIN CHARACTERIZATION DESIGNED TO OBTAIN THE FULL PICTURE OF YOUR RESIN

At Polymer Char, we have strived for 30 years to become the expert company in the development of innovative and automated solutions for polyolefin characterization. The pursuit of this goal has resulted in a solid portfolio of 14 instruments that cover several different separation techniques necessary for a full characterization. All of the analytical equipment can integrate any of three Infrared Detectors developed in-house, as well as other types of detection systems such as Viscometry and Light Scattering.

Every instrument's technique is also available in the form of analytical services provided to our customers according to their specific needs. All the analyses are performed in a cutting-edge laboratory that has served over 35 countries worldwide. More recently, we launched LabAID, a line of accessories that solves the inconvenient tasks performed in the laboratory that are too manual and too time-consuming. Now, we are beginning to bring our expertise onto the analysis of other polymers, and with this latest venture, we continue expanding our portfolio to become the top all-round solutions provider in polymer analysis.

INSTRUMENTS FOR
MOLAR MASS DISTRIBUTION

The analysis of the Molar Mass Distribution of Polyethylene and Polypropylene resins by GPC/SEC has always been considered a demanding task due to the implications of high temperature operations for sample dissolution, and the use of multi-detection methods, a combination that results in complex hardware. We offer two solutions that are simple to operate but powerful at the results they provide. Each instrument is designed for different environments, but both tackle the challenges of high temperature GPC like no other equipment in the market.

GPC-IR®

This is a fully-automated, high-temperature GPC/SEC dedicated to polyolefin analysis with three optional Infrared detectors. The IR4 is available for measurement of concentration and composition of short-chain branching or carbonyls; IR5 offers composition measurement of short-chain branching with high-sensitivity thanks to an MCT sensor that is thermoelectrically cooled without the need of liquid nitrogen. The latest IR6 detector, offers the same advantages as the IR5 but with the added capability of measuring the carbonyls group with high sensitivity in the bands of 1710-1740 cm-1. Viscometer and Light Scattering detectors can also configured in this system.

GPC-QC

GPC-QC is a compact, high-temperature GPC instrument for quality control in polyolefin manufacturing lines. The instrument has a simple and reliable approach that provides robust and precise Molar Mass Distribution. Unlike the traditional parameters used in quality control, which only make reference to the MM and lack precise information, GPC-QC delivers the complete MMD necessary for the production of complex products. The simplified workflow processes one sample at a time without manual solvent handling and with a fully-automated sample preparation. The complete analytical cycle takes approximately 30 minutes, including the dissolution period.

CEF
CEF-QC
TGIC
CRYSTAF
CRYSTAF-TREF

INSTRUMENTS FOR

CHEMICAL COMPOSITION DISTRIBUTION

Chemical Composition Distribution (CCD) is often the most discriminating feature in a complex polyolefin. CCD together with Molar Mass Distribution (MMD), and their interdependence, accurately provide the best definition of a polyolefin´s microstructure.

CEF is a technique patented by Polymer Char.

CEF

Crystallization Elution Fractionation (CEF) is the instrument of choice for Chemical Composition Distribution results because it combines the powerful separation techniques of CRYSTAF and TREF, but it can also perform as TREF alone, TGIC, and Dynamic Crystallization (equivalent to CRYSTAF). Concentration values are measured by an Infrared (IR) detector, which also provides information about comonomer content. Further data on molar mass and chemical composition interdependence can also be obtained by adding a Viscometer detector. Despite its strong capabilities, CEF is a reliable and straightforward apparatus that can analyze up to 42 samples a day in a fully-automated approach.

CEF-QC

This instrument is the most recent addition to the Quality Control portfolio. CEF-QC is a compact and simplified Crystallization Elution Fractionation instrument for Process Control in production plants. It delivers the complete chemical composition distribution curve for one sample in less than 1 hour (including sample dissolution). Density results are also provided to facilitate a direct correlation with the traditional process control data in the plant. This powerful instrument can be operated as a CEF, TREF or TGIC, yet, it remains simple in hardware and operation requirements.

TGIC

The Thermal Gradient Interaction Chromatography (TGIC) technique uses carbon-based adsorbents to characterize the chemical composition distribution in polyolefin copolymers. This technique requires a cooling (adsorption) and a heating (desorption) step. Elution of the sample takes place in that last heating step, observing (in the case of polyethylene copolymers) a linear dependence of comonomer content to desorption temperatures similar to TREF and CEF, and being molar mass-independent above 20,000 Da. The analysis of elastomers and other amorphous polyolefins are the main applications for TGIC.

TGIC will adsorb polymer molecules by the level of molecular surface in contact with the surface of the adsorbent, thus, it may discriminate polymers by the level of irregularities in the chain, in a similar approach to crystallization techniques. TGIC, however separates by adsorption and no co-elution is expected.

TGIC is a technique patented by The Dow Chemical Company and licensed to Polymer Char.

CRYSTAF

CRYSTAF is a fully-automated instrument intended for the fast measurement of the Chemical Composition Distribution (CCD) in polyolefins. It performs the Crystallization Analysis Fractionation technique to separate the polymer by its comonomer content. The process is done in a single temperature ramp (crystallization step) while monitoring the concentration in the polymer solution by the infrared detector IR4.

The virtual instrumentation software controls the full process, which does not require any manpower. After putting the dry samples into the crystallization vessels, the instrument fills the vials with solvent and performs dissolution, crystallization, and sampling. Up to 5 different samples can be analyzed at a time in 8 hours under standard conditions. The vessels and lines are automatically cleaned at the end of each process, and the instrument is ready to analyze more samples. The results of the Chemical Composition Distribution are obtained directly from the software.
CRYSTAF is a technique patented by The Dow Chemical Company and licensed to Polymer Char.

CRYSTAF-TREF

CRYSTAF and TREF are both techniques that measure the Chemical Composition Distribution in polyolefins; however, CRYSTAF analyzes it in the crystallization cycle while TREF does it during the dissolution cycle. Each technique provides complementary information about the CCD for some complex PP-PE resins, which would not achive a thorough separation by using one method alone. So the combination of the two in a single instrument is ideal for the CCD analysis of some polyolefins. CRYSTAF-TREF is capable of running both techniques using the same hardware simply by changing the configuration of the system.

INSTRUMENTS FOR BIVARIATE DISTRIBUTION

The direct measurement of the two-dimensional distribution by cross-fractionation of Molar Mass and Chemical Composition is the most comprehensive way of obtaining the full definition of the microstructure in polyolefins.

CFC

This is an automated, high-resolution Cross-Fractionation Chromatography instrument recommended for the comprehensive characterization of complex materials. The two-dimensional distribution interrelating molar mass and chemical composition is the only technique that fully reveals the most difficult resins without any loss of information. The CFC technology measures the full bivariate distribution in hours instead of days, with limited consumption of solvent, no manual intervention, and in an intrinsically safe setup. CFC can also be configured to be used as a GPC-IR instrument with some minor modifications.

SGIC 2D

The Two-Dimensional Solvent Gradient Interaction Chromatograph (SGIC 2D) instrument performs an analytical fractionation of the polymer according to chemical composition by selective adsorption/desorption on an HPLC column, followed by a second separation according to molar mass on a GPC/SEC column. The instrument is fully-automated, and the virtual instrumentation software controls the whole process.

SGIC 2D is a technique patented by The Dow Chemical Company and licensed to Polymer Char.

INSTRUMENTS FOR SOLUBLE FRACTION DETERMINATION

The Soluble Fraction test is used in Quality Control to measure the amount of amorphous content in polypropylene and ethylene-propylene copolymers. We have two systems available, both capable of obtaining the Soluble Fraction % with accuracy and in a simplified and automated way. Each of the two instruments is designed to fulfill specific needs required by different environments.

CRYSTEX® 42

This is a high-throughput and fully-automated system that obtains the soluble fraction in polypropylene and copolymers. Ethylene content and intrinsic viscosity are also obtained simultaneously for the crystalline matrix, the soluble fraction, and the whole resin in the same analysis. The entire process, which is free of manual work, takes approximately 2 hours per vial, and multiple consecutive samples of small size can be analyzed uninterruptedly by the autosampler. This instrument is designed to be used in a central laboratory to analyze large batches of pelletized, more homogeneous samples.

CRYSTEX® QC

Based on the same TREF separation concept as CRYSTEX® 42, CRYSTEX® QC also obtains the amorphous fraction, ethylene content, and intrinsic viscosity in a completely automated process but it is designed for plant environments. This instrument works in continuous operation for Quality Control, analyzing larger amounts of sample (up to 4g) to ensure enough representativeness of the batch. All of the results are ready in approximately 2.5 hours and the instrument can immediately start over with the analysis of a new sample.

INSTRUMENTS FOR INTRINSIC VISCOSITY

The determination of solution viscosity in polymeric materials is very important in the industry, both in research and manufacturing. It can be used to estimate the molar mass, providing important information relating to the physical properties of polymers. Intrinsic Viscosity (IV) in polymers is traditionally used for its value in specifying and controlling production grades.

IVA

The Intrinsic Viscosity Analyzer (IVA) is our alternative to the traditional glass capillaries method known as the Ubbelohde type. IVA is an automated proposal for the reliable analysis of intrinsic viscosity in polymeric materials. The system integrates a robust dual-capillary relative viscometer combined with an autosampler of 42 sample-capacity. IVA dissolves and analyzes, at high-temperature, a wide range of polymers with IV values from 0.1dL/g up to over 40dL/g, such as polyolefins, PET, PAN, PMMA, and others, by using almost any organic solvent. All of the results are in good agreement with the traditional methods of reference.

The IVA capillaries and tubing do not require manual washing or rinsing and provide robust and precise viscosity values over time. The careful design of the heated compartment and transfer lines ensure that no cold spots are found, so even the most challenging polymers can be analyzed.

The total time of an IVA analysis depends on the dissolution time and number of injections done per vial. However, each injection of every vial typically lasts an approximate of 15 minutes. One hour for dissolution should be added to the total time, but only for the first sample because the dissolution of all consecutive samples is carried out while the previous one is being analyzed.

INSTRUMENTS FOR

PREPARATIVE FRACTIONATION

Preparative Fractionation of a resin obtains the physical fractions of a polymer, and it is a powerful approach in polyolefin characterization research. The resulting fractions can be analyzed later by other techniques such as GPC, TREF, CRYSTAF, NMR, FTIR or DSC, or they can also be used to perform mechanical testing.

PREP C20

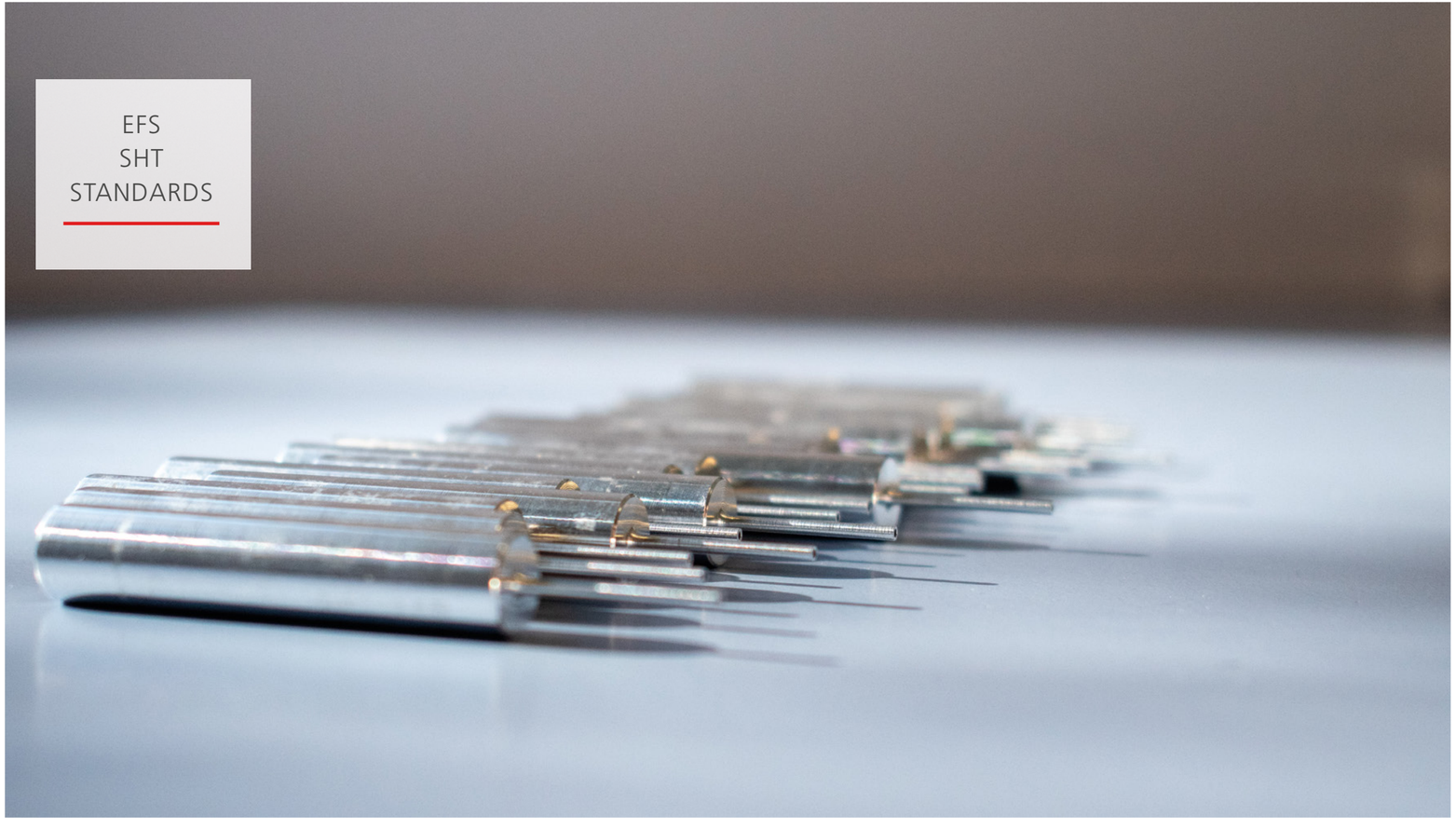
PREP C20 is a fully-automated preparative pilot-plant type instrument that fractionates in a column's support, large amounts of polymer in two modes. It can fractionate according to the polymer's chemical composition through a Temperature Rising Elution Fractionation (TREF) process. Or it can fractionate according to Molar Mass, by modifying the solvent power through a solvent non-solvent combination, typically in isothermal conditions.

PREP C20 facilitates cross-fractionation studies (fractionation first and follow-up analysis through GPC/SEC or TREF), which are necessary tools for fully-characterizing polymer resins. The fractions obtained can be further analyzed by spectroscopic techniques and used for micromechanical testing.

TGIC and SGIC fractionation modes have been recently added.

PREP MC2

PREP mc2 is an instrument designed for semi-preparative fractionation of polymers by molar mass with a solvent non-solvent approach, or by composition with TREF and CRYSTAF approaches. The samples are put into the vessels and the fractionation is performed automatically according to the selected method's conditions. Up to 16 fractions can be obtained when using one of the sample vessels. Two samples can be fractionated simultaneously in the TREF and Molar Mass modes.



LabAID
by Polymer Char

ACCESSORIES FOR THE LABORATORY

Originally designed to be used internally, at Polymer Char we created several tools aiming to improve the efficiency and convenience of the daily tasks in our laboratory. These useful accessories are now available to our customers.

EXTERNAL FILTRATION SYSTEM & EXTERNAL DISSOLUTION OVEN

The EFS is an automated, fast, and innovative apparatus for eliminating carbon black, catalysts residues and other additives of small-particle size that are often present in polyolefin samples. The process is fast, easy and safe for the user because neither solvent handling nor manual vial transfer are required. After the sample has been dissolved, the user puts the vial in the system and starts the operation. The solution is then automatically transferred to an empty vial while passing through a disposable filtration cartridge. Around 2 minutes later, the sample is clean and ready to be injected into the analytical instrument.

Prior to filtration, the sample should be dissolved using the External Dissolution Oven (EDO). The EDO is a compact and independent oven with capacity of up to six samples in vials of either 10 mL or 20 mL for the external dissolution of samples.

SOLVENT HANDLING TROLLEY

One of the most tedious tasks in a polymer separation laboratory, where techniques such as GPC/SEC, TREF, CEF or similar ones are performed, is transferring large volumes of fresh solvent to the instruments in order to maintain a continuous flow through the columns; and later disposing the used solvent into a waste container. Solvent transfer is typically done with 2L or 1 gallon bottles, which are heavy, especially when handling chlorinated solvents. In addition to the heavy lifting involved, it is also necessary to take several protective measures to carry out the operation without incurring personal safety risks. Wearing a mask is also required to avoid inhalation of vapors.

The Solvent Handling Trolley (SHT) has been designed to address all of these difficulties, and minimize the risks prone to happen when manipulating solvents in the laboratory. Its operation is very easy, thought to make the process faster and simpler. In a single operation, the SHT can fill an instrument's bottle with fresh solvent, and empty the used solvent in a different bottle. The bottles have enough capacity to perform the filling and emptying operations of several instruments consecutively.

STANDARDS

There are three types of standards available:

GPC/SEC Polystyrene Kit (ready for calibration, a pack of 5 x 4 vials)

This calibration kit is a mixture of 16 different polystyrene resins, already pre-weighted and dried into Polymer Char's autosampler vials for the calibration of GPC columns or any of our other systems.

Soluble Fraction Polypropylene Calibration Kit

The Soluble Fraction Calibration kit includes 25g of five different polypropylene samples with different soluble fraction values within a wide range, including a homopolymer and other polypropylene resins with higher soluble fraction values.

Composition Calibration Standard Samples Kit

This kit includes six PE copolymer resins with different octene content, so it can be used for Polymer Char's Infrared Detectors calibrations in Short Chain Branching.

ANALYTICAL SERVICES

Whether your requirement of a techinque is occasional or your sample is particularly special, you can leave it up to us to perform a comprehensive and reliable analysis. If you are not sure about what service suits your sample best, contact our team to receive professional assessment.

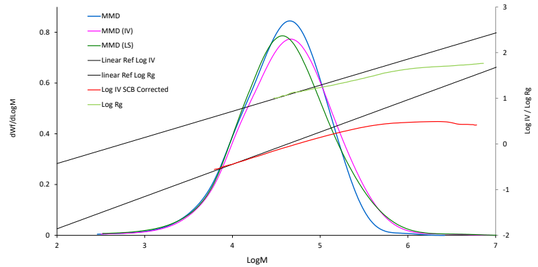
Molar Mass Distribution
Analytical Services

Size-Exclusion Chromatography (SEC), also known as Gel Permeation Chromatography (GPC), is a liquid chromatography technique that separates molecules according to their size. Samples need to be dissolved first and then injected into the GPC columns, where the separation occurs. The larger the molecules, the more they will be excluded from available pores in the column packing and the earlier they will elute. At Polymer Char, we perform GPC/SEC analyses for polyolefins by using our own high-temperature Instruments, GPC-IR® and GPC-QC.

The analysis perfomed by GPC-IR® uses an internally developed Infrared Detector with the best sensitivity for Concentration and Composition to obtain the Molar Mass Distribution curve and SCB (Short-Chain Branching) information. Other detectors can be added to the analysis, such as Viscometer or Light Scattering to obtain more complete results in MWD, SCB, LCB. When the analysis is performed with the GPC-QC instrument, rapid columns are used to perform the analysis in a very short time.

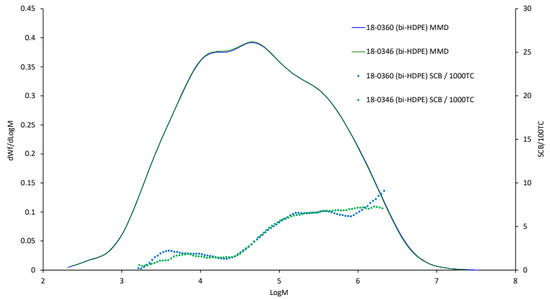
In both cases, a report is sent to the customer with the Molar Mass distribution curve, the analysis conditions that were used, as well as the calculations of Mn, Mw, and others. An Excel file with the raw data can also be sent if the customer requires it.

GPC-IR Triple Detection System



Overlay of Mark-Houwink (MH) plots and Conformation plots of the branched polymers against a linear reference polymer is used to analyze the presence of long chain branching (LCB)

GPC-QC MMD bi-HDPE (2 replicates)



MMD and short chain branching (SCB) frequency measured by GPC-QC for a bimodal HDPE sample (dual reactor process). The overlay of the 2 injections shows an excellent precision in the analysis process.

Chemical Composition Distribution
Analytical Services

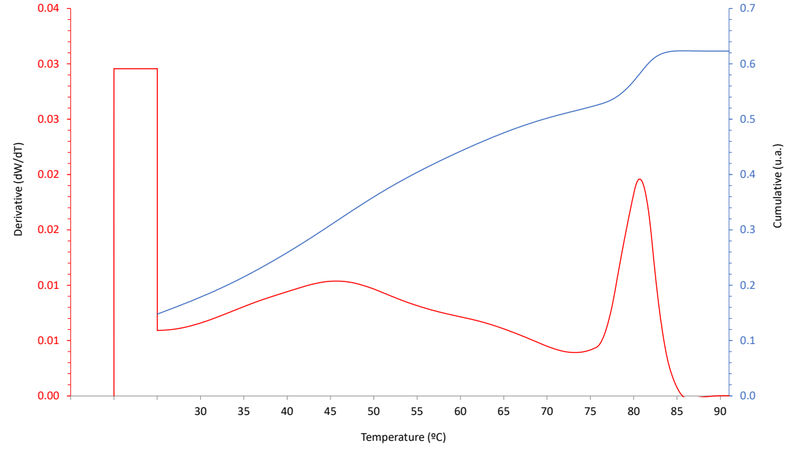
Most polyolefin products are produced with the incorporation of comonomers to reduce crystallinity and to extend the range of product performance. To define these copolymers, a chemical composition or comonomer incorporation parameter is required in addition to the molar mass distribution.

This is the case of Linear Low Density Polyethylene (LLDPE), Low Density Polyethylene (LDPE) or Polypropylene (PP), where the incorporation of comonomers such as Butene, Hexene or Octene results in short-chain branches or small amounts of Ethylene (in the case of PP) that influence crystallinity, final density and the performance of a resin.

The services we offer for obtaining the Chemical Composition Distribution curve (CCD) are available in different techniques: Crystallization Analysis Fractionation (CRYSTAF), Temperature Rising Elution Fractionation (TREF), Thermal Gradient Interaction Chromatography (TGIC) or Crystallization Elution Fractionation (CEF). Our recommendation for which service to use comes after an evaluation of your type of sample.

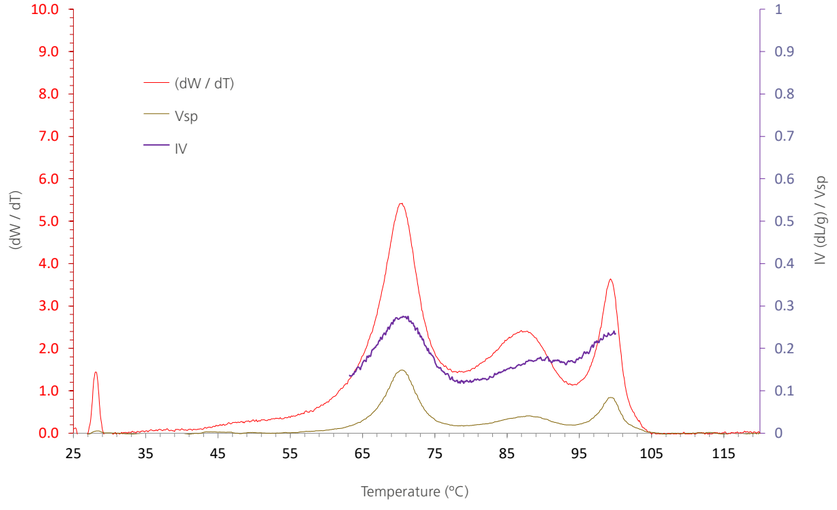
CRYSTAF is a technique patented by The Dow Chemical Company and licensed to Polymer Char.

CRYSTAF results of a LLDPE



Crystallization Analysis Fractionation is a technique used to measure the Chemical Composition Distribution (CCD) in polyolefins based on the segregation of crystals of different morphology or comonomer content by crystallizability. In this technique, separation and analysis are performed in a single step; the crystallization cycle, where the polymer solution is sampled and its concentration is analyzed by an infrared detector (IR4) while the temperature decreases for crystallization. The concentration data obtained at each temperature sampled corresponds to the cumulative curve of the CCD.

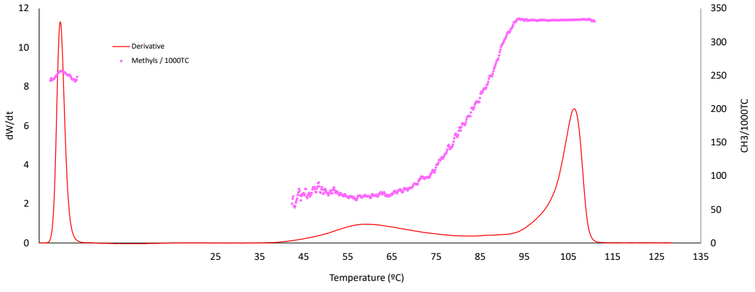
Analysis of an LLDPE sample by TREF with IR and Viscometer Detectors



Temperature Rising Elution Fractionation is a well-known technique for the characterization of the Chemical Composition Distribution (CCD) in polyolefins. The concentration of the sample is measured by an infrared detector, which can also offer information about comonomer content if a composition sensor is added. More information can be obtained by adding a Viscometer detector.

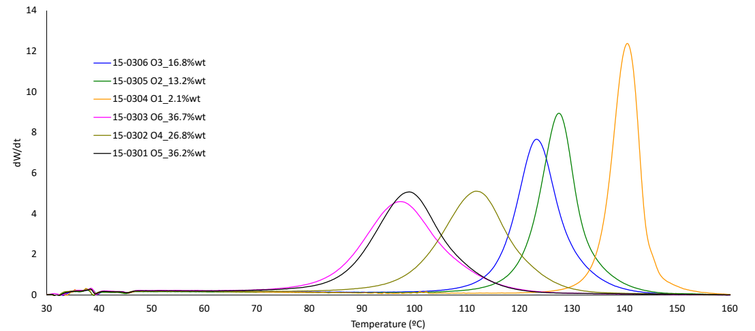
Crystallization Elution Fractionation is based on a crystallization concept that combines the power of CRYSTAF and TREF to get the separation of the different components of the polyolefin in a significantly shorter time.

Ethylene-propylene Copolymers by CEF 2-4-1



Thermal Gradient Interaction Chromatography is an HPLC technique that has become available for the analysis of more amorphous polyolefins. The separation is based on adsorption on an atomic level flat surface such as graphitized carbon. Certain low-crystallinity samples may benefit from this technique when they cannot separated with the traditional CCD techniques.

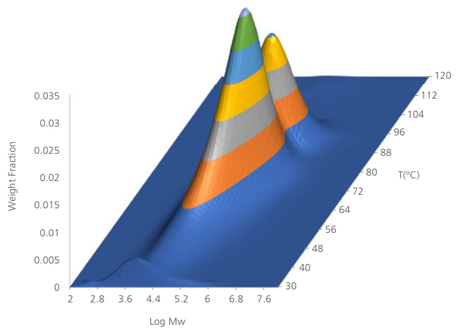
Ethylene Octene Copolymers by TGIC 20-2-0.5



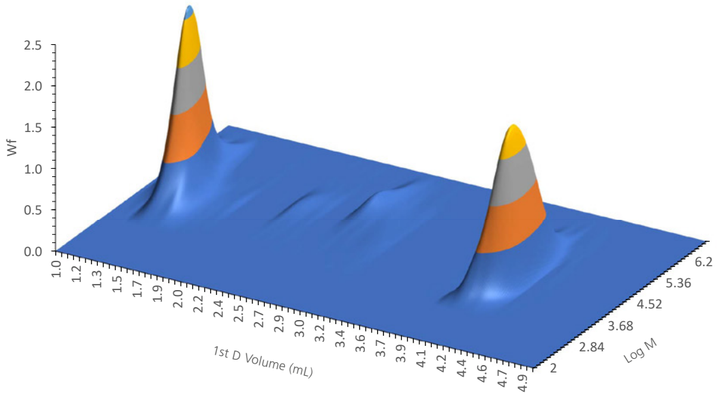
Bivariate Distribution
Analytical Services

The direct measurement of the two-dimensional distribution by **Cross-Fractionation Chromatography** in terms of both molar mass and chemical composition is the most comprehensive way of obtaining a full definition of the microstructure in polyolefins. This goal can be achieved by coupling GPC and TREF or TGIC techniques. The separation power of each dimension, (CCD by TREF or TGIC, and MMD by GPC), are combined to produce a comprehensive bivariate description of the polymer microstructure.
The results can be obtained by different sequential methods, and also directly by using a CFC Instrument.

Bivariate Distribution of a PP Copolymer by CFC



Bivariate distribution by SGIC 2D



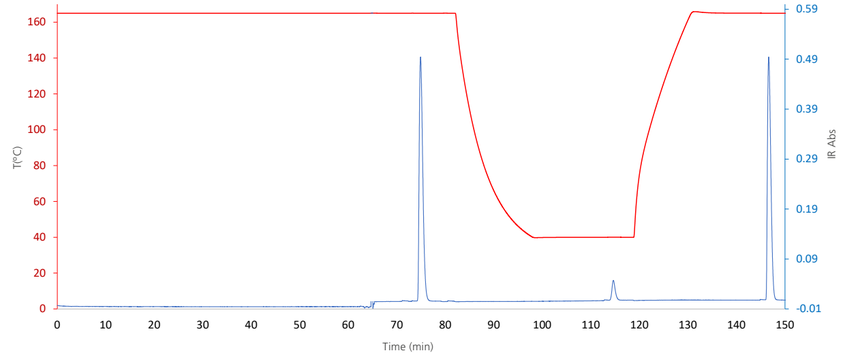
A two-dimensional chromatography analysis can be performed with the **Solvent Gradient Interaction Chromatography 2D Instrument,** developed for a detailed study of the chemical composition – molar mass bivariate distribution of amorphous or low crystallinity polyolefins and functionalized polyolefins. Chemical composition separation is achieved by a gradient of solvents in an interaction chromatography column as a first dimension, followed by molar mass separation in a second dimension by isocratic GPC/SEC. The infrared detection provides direct measurement of chemical composition in polyolefins (methyls content, comonomer weight fraction). A report is sent to the customer with the bivariate distribution graphs, single-dimension recovered graphs, the analysis conditions that were used, as well as tabular data with the fractions' average results. An Excel file with the raw data can also be sent when required.
SGIC is a technique developed and patented by The Dow Chemical Company and licensed to Polymer Char.

Soluble Fraction Measurement
Analytical Services

This service is intended to obtain the Soluble Content (Xylene Solubles equivalent) in Poplypropylene and copolymers. The soluble fraction measurement is performed by one of our CRYSTEX instruments using TCB or o-DCB as solvents. The results provided by CRYSTEX are equivalent to the Xylene Solubles results obtained with the gravimetric method (ISO 6427, Annex B). A study conducted by Polymer Char with a broad selection of PP resins shows an excellent correlation between CRYSTEX and the gravimetric method, while obtaining better reproducibility and precision thanks to the full automation of the process.

In addition to Concentration, ethylene incorporation and IV of the original sample, the amorphous fraction, and the crystalline fraction results can also be provided as an option.

Elution of the Whole Sample, the Soluble Fraction and the Crystalline Fraction

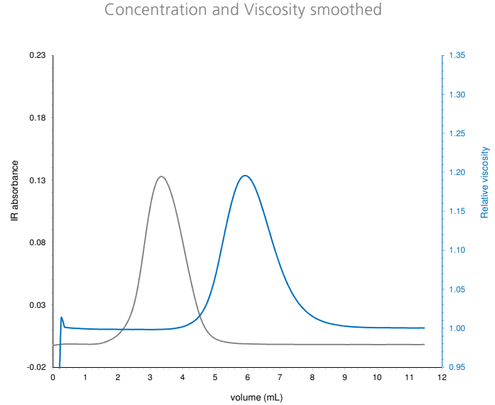


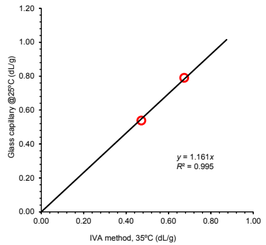
This graph is the result of an analysis performed by the CRYSTEX® technique, in which the whole sample is first loaded and its values of ethylene content and intrinsic viscosity are measured. We then obtain the amount of Soluble Fraction present in the sample; and finally, the third peak corresponds to the crystalline matrix that was left. Once these two parts of the sample are separated, ethylene content and intrinsic viscosity values are also obtained for each of the three fractions.

Intrinsic Viscosity
Analytical Services

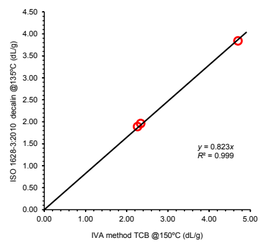
This service is intended to obtain the intrinsic viscosity in polymeric materials, even the most challenging polymers such as high, and ultrahigh molar mass polymers. The analysis of polyolefins is performed in the instrument IVA with TCB or o-DCB as solvents and 160°C as standard conditions and results show a good correlation with decaline results. Analysis of other polymers with other solvents and other conditions are possible too, thanks to our instrument's wide temperature range of up to 200°C.

A study conducted by Polymer Char with different polymers in various solvents – PAN (polyacrylonitrile) in DMF (N,N-dimethylformamide), PET in phenol:o-DCB, PLA in TCB, and polyolefins in TCB and o-DCB – shows that all the intrinsic viscosity results obtained with IVA are in good agreement with the standard methods used as reference (compared to IV obtained with the traditional glass capillaries of the Ubbelohde type ISO 1628-3:2010 f.i.).





Correlation of IV values by IVA, compared to the traditional glass capillary setup for a set of PET samples. In both cases, a mixture of phenol: oDCB (2:3, m:v) was used, with temperatures of 35°C and 25°C respectively.



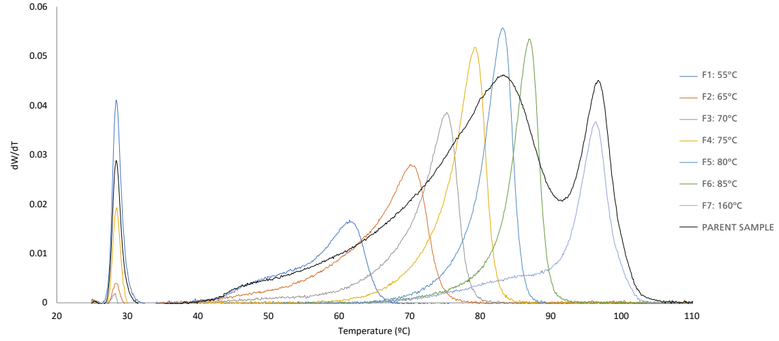
Correlation of IV values by IVA, compared to the standard method ISO 1628-3:2010 for a set of PP samples. The linear correlation is excellent as proved by the high R2 value.

Preparative Fractionation
Analytical Services

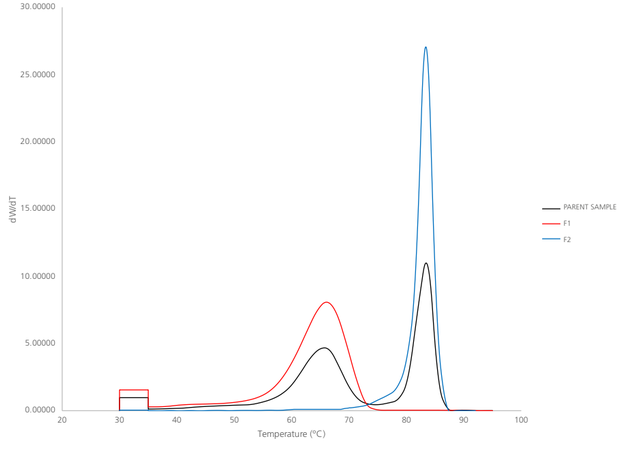
By TREF

The TREF mode is the most common crystallization-based technique in preparative fractionation by chemical composition. Users prefer this mode for CCD fractionation because it is the most predictable process based on the preliminary TREF analysis of the sample to be fractionated.

7 Fractions of a LLDPE by Chemical Composition (TREF)



Fractionation in CRYSTAF Mode



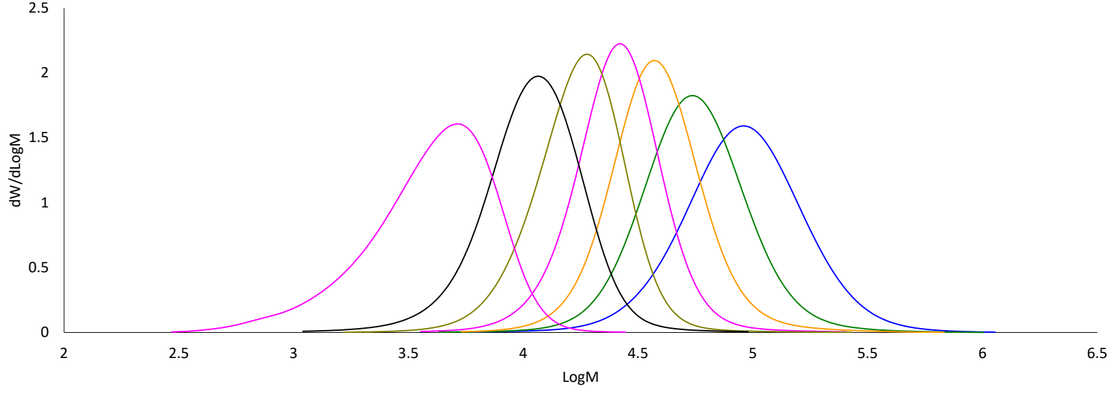
By CRYSTAF

In some complex resins, a fractionation by TREF may not render the expected results, but the CRYSTAF mode will do it properly. A specific method is selected by performing TREF and CRYSTAF analysis on the parent sample. This fractionation method is more time consuming than the TREF mode because of the re-dissolution and crystallization steps, which need to be performed for each fraction.

By MOLAR MASS

Molar Mass fractionation is based on the solvent interaction with the polymer chains and it is typically performed by precipitation or dissolution, at isothermal conditions, by modifying the solvent power through a solvent, non-solvent combination. The obtained fractions are later analyzed by GPC to confirm the good performance of the fractionation and sent to the customer in a summary report together with the physical fractions.

7 Fractions by Molar Weight analyzed by GPC-IR

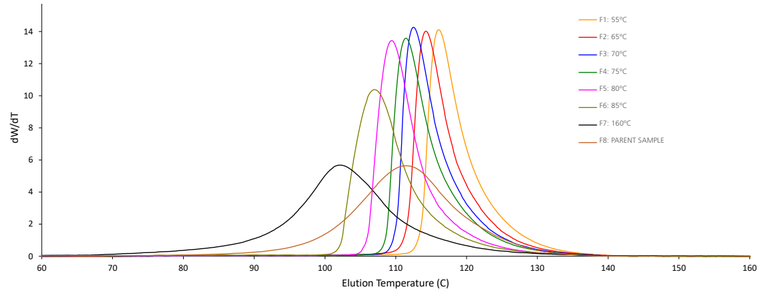


By TGIC or SGIC

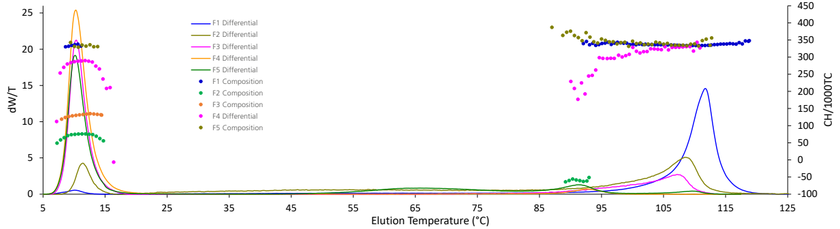
High Temperature Interaction Chromatography for polyolefins is an alternative to crystallization-based techniques for separation of components with low crystallinity by composition, such as ethylene-propylene copolymers, EPDM resins, high- impact polypropylene, and olefin block copolymers.

In TGIC fractionation, separation is based on the adsorption-desorption of the molecules on the graphitic surface with temperature gradients, whereas in SGIC, the separation is based on the same adsorption-desorption process but this time, at isothermal conditions with solvent gradient.

7 Fractions of an Ethylene Propylene Copolymer by TGIC



Fractionation of an HECO sample by SGIC in 5 Fractions



POLYMER CHAR INSTRUMENTATION: COMPARATIVE TABLE

FAMILY / INSTRUMENT	RESULTS*	RECOMMENDED APPLICATION	# OF SAMPLES AUTOMATICALLY ANALYZED	ANALYSIS TIME PER SAMPLE (UNDER STANDARD CONDITIONS, INCLUDING DISSOLUTION)		DETECTORS					# OF COLUMNS	OTHER MODES	FOR SAMPLES OF TYPE
				1st Sample	Consecutive Samples	IR4	IR5	IR6	V	LS			
MOLAR MASS DISTRIBUTION													
GPC-IR®	MMD, SCB, LCB, IV	R&D	42	95′	35′	Standard	Recommended	Optional	Optional	Optional	3-4	-	POLYOLEFINS
GPC-QC	MMD, SCB, LCB, IV	Production Control	1	45′	45′	Standard	Recommended	n/a	Optional	n/a	1-3	-	
CHEMICAL COMPOSITION DISTRIBUTION													
CEF	CCD, SCB, IV	R&D	42	90′	45′	Standard	Recommended	Optional	Optional	n/a	1	TREF, TGIC, DC	
TGIC	CCD, SCB, IV	R&D	42	90′	45′	Standard	Recommended	Optional	Optional	n/a	1	CEF, TREF, DC	
CRYSTAF	CCD, SCB	R&D	5	6 h / 5 samples		Standard	n/a	n/a	n/a	n/a	-	-	
CRYSTAF-TREF	CCD, SCB	R&D	5	5 h / sample		Standard	n/a	n/a	n/a	n/a	1	CRYSTAF /TREF	
CEF-QC	CCD, SCB, IV	Production Control	1	30´- 45´	30´- 45´	Optional	Recommended	n/a	Optional	Optional	1	TREF, TGIC, DC	
MOLAR MASS DISTRIBUTION X CHEMICAL COMPOSITION DISTRIBUTION													
CFC	MMD x CCD, SCB	R&D	42	16 h	15 h	Standard	Recommended	Optional	n/a	n/a	3 (GPC)+1(TREF/TGIC)	GPC	
SGIC 2D	MMD x CCD, SCB	R&D	42	6 h	5 h	Standard	Recommended	Optional	n/a	n/a	1 (GPC) + 1 (SGIC)	GPC	
SOLUBLE FRACTION % MEASUREMENT													
CRYSTEX® 42	(SF, IV, C2%)**	R&D / Production Control	42 positions***	3 h	2 h	Standard	n/a	n/a	Optional	n/a	1	-	
CRYSTEX® QC	(SF, IV, C2%)**	R&D / Production Control	1	2.5 h	1.5 h	Standard	n/a	n/a	Optional	n/a	1	-	
INTRINSIC VISCOSITY ANALYSIS													
IVA	IV, Concentration	R&D / Production Control	42	45´-105´	15′ with injection loop	Optional	n/a	n/a	n/a	n/a	-	-	POLYOLEFINS AND OHTER POLYMERS
PREPARATIVE FRACTIONATION													
PREP C20	Fractionation	R&D	1 sample up to 10 fractions			Optional	n/a	n/a	n/a	n/a	2 (TREF & MM modes) / 1 (TGIC mode)	TREF, MM, TGIC, SGIC	
PREP mc2	Fractionation	R&D	2 samples up to 8 fractions per sample or 1 sample up to 16 fractions			n/a	n/a	n/a	n/a	n/a		TREF, CRYSTAF, MM	

*MMD (Molar Mass Distribution), CCD (Chemical Composition Distribution), SCB (Short-Chain Branching), LCB (Long-Chain Branching),
IV (Intrinsic Viscosity), SF (Soluble Fraction), C2% (Ethylene Content), DC (Dinamic Crystallization).
**Results for the whole sample, the soluble fraction, and the crystalline fraction.
*** The number of samples that can be analyzed consecutively depends on the analysis conditions.

PREVENTIVE MAINTENANCE CONTRACTS

	Basic	Standard
Availability	Anytime	Anytime
Valid Period	1 year (Jan - Dec)	1 year (Jan - Dec)
Instrument verification	Via trace and log files	On-site
Set of consumable parts	✓	✓
Replacement parts	25% Discount	25% Discount
Free software updates	✓	✓
Small hardware upgrades	✓	✓
Free remote control access for consultation, updates, diagnostics, and hardware testing	✓	✓
Email and telephone support	✓	✓
Preventive maintenance visit*	-	1
Additional service visits	25% Discount	25% Discount

*One planned visit to the customer's laboratory by a Polymer Char engineer to perform instrument testing and preventive maintenance tasks. This visit is not intended for repairing a malfunctioning instrument nor for starting-up an instrument after a long period of inactivity. The maintenance visit must be organized at least three months in advance to arrange the engineer's travel agenda. Subject to availability, part of the time can be dedicated to an on-site presentation on new technologies and applications. The time allocated to a maintenance visit is 8 hours for 1 instrument, plus 4 hours per additional instrument included in the service plan. E.g.: 16 working-hour visit for 3 instruments.

UTM
Users Training Meeting

ANNUAL USERS TRAINING MEETING

The UTM is a highly recommended program that teaches everything about Polymer Char instrumentation including daily operation, preventive maintenance, troubleshooting procedures or calculations. The meetings are organized once a year at the Polymer Char offices in Valencia, Spain, and every two years a session is held either in China or USA, following the International Conference on Polyolefin Characterization (ICPC).

CUSTOM TRAINING

We also offer training sessions built specially for your requirements. You can benefit from personalized attention to maximize the performance of your instruments or deepen your knowledge of a specific characterization technique (GPC/SEC, TREF, CRYSTAF, CEF, TGIC, SGIC 2D, CFC). The training sessions can be held on-site or remotely.

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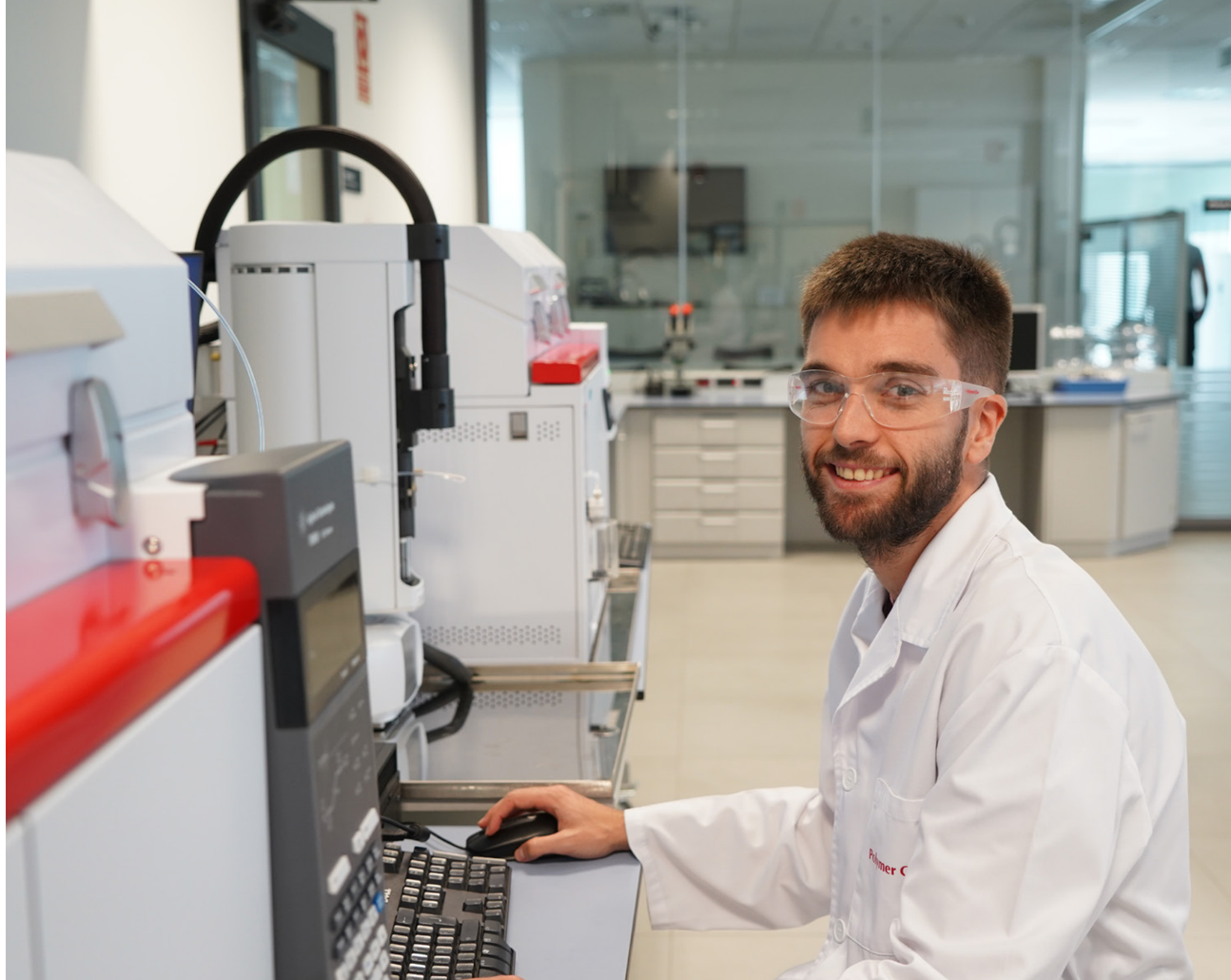

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