



# Devoted to Polyolefin Science

An aerial night photograph of a modern city, likely Valencia, Spain. The image shows a large, illuminated stadium with a distinctive white, curved roof structure. In the foreground, a multi-lane highway is visible, with light trails from cars. The city lights extend into the distance under a dark blue sky.

## Your Partner in Polyolefin Characterization

With headquarters in Valencia, Spain, Polymer Char offers a broad range of modern instruments and analytical services for Polyolefin Analysis, standing out in GPC/SEC with GPC-IR®, in Chemical Composition Distribution with CRYSTAF, TREF or CEF, in Cross Fractionation Chromatography with CFC, and in Soluble Fraction analysis with CRYSTEX® QC and CRYSTEX® 42. More recently, two instruments were added to the portfolio: GPC-QC for measuring molar mass distribution in a plant environment, and IVA for the analysis of intrinsic viscosity in a wide range of polymers. Also in the solutions offered is LabAID, a line of accessories for facilitating daily operations.

With equipment installations in leading petrochemical companies, government laboratories and universities in over 25 countries and analytical services provided to 35 countries, Polymer Char has clearly become the leader in research, engineering, software and service in Polyolefin Characterization.

After dedicating 25 years to polyolefins, the company is now starting to transfer its expertise and innovative approach to the analysis of other polymers as it broadens its scope of solutions.



For over two decades Polymer Char has been the sole instrumentation company in the world fully dedicated to the microstructural characterization of polyolefins.

We stay ahead in the industry by developing new technologies that help polymer researchers know more about their polyolefin products.

# Overview

## Company Profile

|                 |   |
|-----------------|---|
| Founded:        | September, 1992.  |
| Headquarters:   | Valencia, Spain.  |
| Products:       | Instrumentation for Polymer Analysis, Infrared Detectors, Software and Accessories.     |
| Services:       | Analytical and Fractionation Services, Training and Consulting.                         |
| Markets served: | Petrochemicals.<br>Government Research.<br>Private Research Organizations.<br>Academia. |
| Areas served:   | Worldwide.  |
| Distribution:   | External network partners established in Latin America, Middle East and Asia Pacific.   |

### Company, Products and Scope

Polymer Char is devoted to the development of state-of-the-art instrumentation for Polyolefin Analysis, and other Polymers as well.

The company offers the broadest and most modern range of instruments and services for structural characterization of polyolefins, covering areas such as Gel Permeation Chromatography (GPC/SEC), Chemical Composition Distribution, Bivariate Distribution, High Temperature HPLC, Soluble Fraction measurement and Quality Control, Preparative Fractionation and Infrared Detection.

Polymer Char is also well known for its advanced approach to Virtual Instrumentation Software Architecture (VISA) that, together with excellent remote control capabilities and its strong commitment to Customer success, places the company at the leading edge of instrumentation diagnostics and technical support.

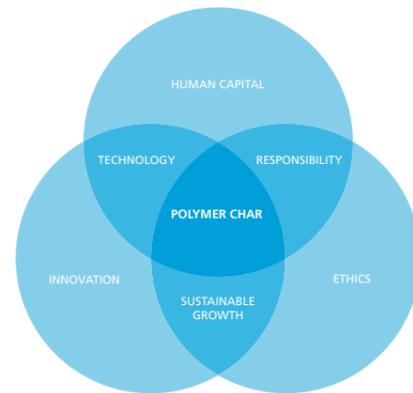
Together with its global network of partners and distributors, Polymer Char supplies, trains and supports Customers worldwide. The company provides analytical services to more than 35 countries, and its instruments are present today in over 25 countries within America, Europe, Africa, Middle East and Asia Pacific, predominantly serving Polymer Producers and Processors, Government and Contract Research Laboratories, and Universities that work on polymer research.

In the last two decades and with an average annual investment of 20% of its manpower resources dedicated to R&D, Polymer Char has played a key role in the development of most of the existing polyolefin characterization technologies, such as CRYSTAF, CRYSTEX®, CEF, automated CFC and TREF, or GPC with IR detection. Each new project, each new analysis, adds recognition to Polymer Char as The Polyolefin Characterization Company.

### Mission

Polymer Char's Mission is to become the global leader in development of state-of-the-art instrumentation, as well as in analytical and consulting services; in the field of polymer characterization.

Polymer Char carries out its Mission with responsibility, with a technology and innovative driving-force through significant R&D activities, maintaining high quality standards and services and commitment in all of its activities, respecting its Employees, Customers, Suppliers, Distributors and the Environment.



### Values

As illustrated in the graph above, Polymer Char's Values are based on three pillars: quality of the human capital that compose the company (1), a clear orientation to innovation (2), and practicing ethics on everything that is done (3).

Time by time, these values have demonstrated to become the main formula to reach the company Mission, while getting promising results: technology (1), responsibility (2) and sustainable growth (3).

Therefore, Mission and Values are not separate variables at Polymer Char. The company is convinced that 'the whole is greater than the sum of its parts', and the essence of this 'whole' is the spirit of continuous improvement and customer orientation.



### About the Founder

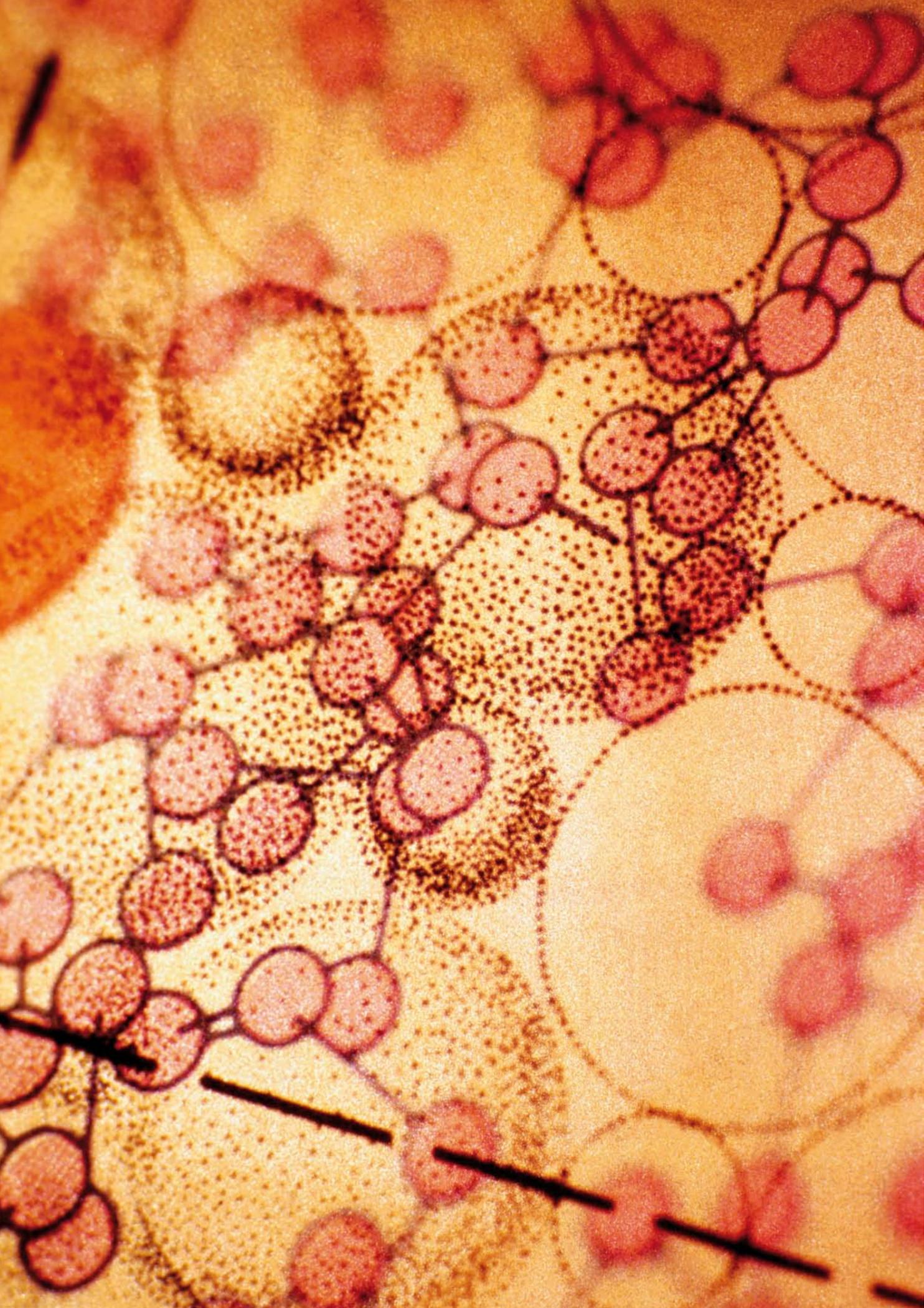
Benjamin Monrabal, was born in 1946 in Valencia, Spain. He received a Chemical Engineering degree from the Instituto Químico de Sarrià in Barcelona; and his PhD in Polymer Chemistry from the Virginia Polytechnic Institute, U.S.A.

From 1970 until 1992, he worked at The Dow Chemical Company, where he was appointed Associate Scientist for his technical contributions to the Polyolefin business, standing out with the invention and patent of the CRYSTAF technique.

In 1992 he founded Polymer Char, with the vision to develop a commercial and fully-automated CRYSTAF and other instruments based on new techniques aimed to provide important microstructural information on the characterization of polyolefins.

During the last two decades, he has invented the CEF separation technique which today is patented, and has been responsible for a new GPC approach.

During his career, and complementary to his work as General Manager and R&D Director at Polymer Char, he has authored many publications on Polyolefins Characterization and is collaborating with various Universities, Research Institutes and leading Polymer companies in the development of new methodologies for extensive characterization of Polyolefins. He has also been a member of the Editorial Boards of the International Journal of Polymer Analysis and Characterization and Journal of Liquid Chromatography.



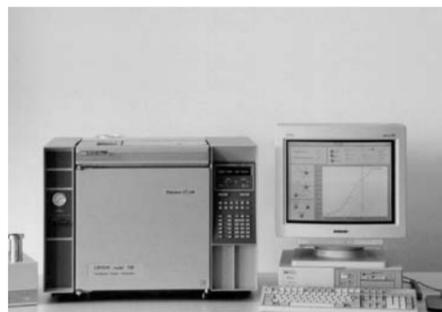
Founded 25 years ago by a recognized Scientist in PO separation techniques, today Polymer Char is a consolidated technology company with innovative and technological instruments.

Collaborating with Customers in complex scientific and engineering projects has significantly contributed to such long-term achievement.

# History

## History at-a-glance

- 1992 Company founded in Spain by Dr. B. Monrabal.
- 1994 Presented a commercial CRYSTAF in Chicago.
- 1996 Developed PREP mc<sup>2</sup> and an automated TREF.
- 1999 Developed CRYSTEX<sup>®</sup> with a Belgian PP company.
- 2005 Developed CEF, holding patent in the U.S.A.
- 2006 Founded and held ICPC with two other researchers. Developed a new CFC with a Japanese company and a new more sensitive Infrared Detector IR5
- 2007 Entered into the HT-GPC market with GPC-IR<sup>®</sup>.
- 2010 Launched Polymer Char new Corporate Brand.
- 2011 Became Global VAR Partner of Agilent Technologies.
- 2012 Launch of the TGIC and SGIC instruments.
- 2013 Developed CRYSTEX<sup>®</sup> QC and PREP C20.
- 2014 Developed CRYSTEX<sup>®</sup> 42, GPC-QC and IVA.
- 2015 Initial development of a unique line of accessories.
- 2016 Developed the EFS.
- 2017 Launch of the Solvent Handling Trolley.
- 2018 Launch a new Infrared Detector, IR6.



#### 1992-1995: The Beginnings

Polymer Char was established by Dr. Benjamin Monrabal in 1992 in the Valencia Technology Park in Spain, being the company registered as Polymer Characterization, S.A.

Its initial goal was to develop a commercial and fully-automated CRYSTAF instrument, a new patented technology developed by Dr. Monrabal at The Dow Chemical Company laboratories in The Netherlands to measure the Chemical Composition Distribution (CCD) in semicrystalline polymers by using only one temperature cycle.

The first CRYSTAF 100 prototype (picture above) was presented in 1994 in Chicago, being the first unit acquired one year later by a chemical company in South Korea.

In 1993, Polymer Char acquired and developed together with a Scandinavian-based leading research institute an infrared detection technology dedicated to polyolefin analysis, to count on the most accurate analysis for its new instruments. Today, practically every polyolefin company in the world counts with a stand-alone IR4 detector to measure concentration and/or composition in HT-HPLC techniques such as Size Exclusion Chromatography. The IR4 has an excellent baseline stability versus the refractive index detectors that are traditionally used in GPC instruments.

Consolidated the performance of the CRYSTAF equipment and with an advanced and precise detector for polyolefin analysis, during the next years Polymer Char continued investigating new techniques and extending its product range for analytical laboratories of large resin producers.



#### 1995-2005: Expanding Portfolio

In 1996, Polymer Char developed an automated TREF system, as well as PREP mc<sup>2</sup> together with a German chemical company, to fractionate polymers by molar mass and by composition.

In 1999, the company launched CRYSTEX®, developed in collaboration with a Belgian polypropylene company to automate the xylene solubles measurement, as a fully robust and reliable alternative to traditional gravimetric methods, that were traditionally performed in PP laboratories.

In the early 2000's, Polymer Char started consolidating its lab services for plastic testing and analysis. Although the analytical services today represent a smaller business unit for the company in comparison to the instrumentation revenues, the opportunity to work together with laboratories operating in over 35 countries, has given Polymer Char scientists a better understanding of the Customer's technical requirements and resin applications. Thus, allowing us to know better which software and detector capabilities need to be improved to provide more suitable solutions to them.

In 2005, Polymer Char developed CEF. Holding a patent today, this equipment was based on an innovative crystallization concept to obtain the CCD in polyolefins, obtaining the same results as TREF but in a much shorter time period.

In the same year, Dr. Monrabal together with Dr. Colin Li Pi Shan, from The Dow Chemical Company and Prof. João Soares, from the University of Alberta, founded the International Conference on Polyolefin Characterization. Having been favorably held the first edition in Houston in 2006, next editions held in Valencia, Shanghai and Texas were also successful. In 2008, Prof. Minoru Terano, from the Japan Institute of Science and Technology, joined the committee, followed by Prof. Dujin Wang, from the Chinese Academy of Sciences, in 2010. Organized by Polymer Char, the ICPC represents nowadays the meeting-point par excellence for Polyolefin experts all over the world.



#### 2005-2010: Consolidating Technologies

In 2006, Polymer Char designed the CFC instrument, following the request of a prestigious Japanese chemical company to develop a new benchtop and fully automated instrument to perform TREF+GPC in a single process; and therefore obtaining the bivariate distribution in 3-dimension plots. With a very good acceptance of this technology from the industry, it became a commercial equipment afterwards.

In 2007, with all the expertise acquired during the previous 15 years in polyolefin analysis together with Dr. Monrabal's experience in Gel Permeation Chromatography, Polymer Char entered in the GPC/SEC field with the GPC-IR® solution, which was designed to address the needs that in the last decade had been demanded by HT-GPC users. Features such as, a fully automated sample preparation, in-line filtration, separate column oven compartment, no solvent handling, a comprehensive data processing software, and the incorporation of a new Infrared Detector (IR5) with outstanding sensitivity in concentration and short chain branching besides, viscometer and light scattering detectors were included. Three years later, GPC-IR® was recognized by the C&EN magazine of the American Chemical Society, as the 5<sup>th</sup> most innovative technology presented at Pittcon within its category.

In 2010, Polymer Char renewed its corporate brand to reach the reputation levels the company had already gained with its innovative solutions. Today, the Polymer Char brand represents a standard of quality and effective customer orientation.

In the same year, Polymer Char arrived to an agreement with Wyatt Technology, the leading company of light scattering, to incorporate its 8 or 18 angle detectors into the GPC-IR® system.

By the end of 2010, Polymer Char had the pleasure of welcoming Dr. Wallace Yau as a Scientific Advisor. Since then, Dr. Yau, a prestigious scientist in GPC/SEC, has been contributing significantly to the improvement of Polymer Char's technology.



#### 2010-2015: Leading the Global Industry

In 2012, the Polymer Char R&D team developed PREP C20, a new column-based preparative fractionation system, capable of fractionating up to 20 grams of polymer. Initially designed for Polymer Char's Analytical Services business unit, it later became a commercial equipment as well.

In the same year, Polymer Char expands its portfolio with new equipments designed for quality control: a high-throughput equipment specially designed for the analysis of intrinsic viscosity, and CRYSTEX® QC, instrument dedicated to measure the amorphous fraction in PP.

Early 2013, Polymer Char arrives to global agreement with The Dow Chemical Company, as the unique authorized licensee to provide instrumentation based on Thermal Gradient Interaction Chromatography (TGIC) and Two-Dimensional Solvent Gradient Interaction Chromatography (SGIC 2D), using carbon-based packings as covered by Dow's patent.

In 2014, Polymer Char continues with the addition of new instruments for Quality Control; CRYSTEX® 42 with the same purpose than CRYSTEX® QC but with capacity for 42 samples; IVA, an intrinsic viscosity analyzer for polymeric materials; and GPC-QC a simplified GPC instrument aimed at control laboratories in polyolefin production plants.

#### 2016-Today: Bridging Gaps

In 2015 the company closed the circle of a complete range of solutions with the commercial launch of a series of accessories specially designed for polyolefin characterization laboratories. The first two launches were SHT and EFS.

Today, as Polymer Char's R&D and Analytical Teams keep investigating new analytical techniques and exploring innovative instrumentation and software capabilities, the company ventures into the analysis of other polymers and the development of new detectors.



TREF, CRYSTAF, High Temperature GPC-IR®, Cross Fractionation, GPC One®, CRYSTEX®, CRYSTEX® QC, TGIC, CEF, Two Dimensional, SGIC, Preparative Fractionation, Infrared Detectors...

Discover our broad range of innovative solutions for analyzing Polyolefins through different separation methods.

# Products

## Products by Title

- CEF
- CFC
- CRYSTAF
- CRYSTAF-TREF
- CRYSTEX®
- CRYSTEX® QC
- CRYSTEX® 42
- Data Unit 200
- EFS
- GPC-IR®
- GPC-QC
- GPC One® Software
- IVA
- PREP mc<sup>2</sup>
- PREP C20
- SGIC 2D
- SHT
- TGIC
- TREF

## CHEMICAL COMPOSITION DISTRIBUTION

### CRYSTAF

CRYSTAF is a fully automated instrument for the fast measurement of the Chemical Composition Distribution (CCD) in Polyolefins.

CRYSTAF performs Crystallization Analysis Fractionation to separate the polymer by its comonomer content. The process is done in a single temperature ramp, while the polymer solution concentration is monitored by using the infrared detector IR4 from Polymer Char.

*Developed by Dr. Monrabal at The Dow Chemical Company laboratories in The Netherlands during 1987 and 1992. U.S. Patent 5,222,390.*

### TREF

Temperature Rising Elution Fractionation has been the most comprehensive technique for the characterization of the CCD in polyolefins, and Polymer Char TREF is the first fully automated apparatus implementing this technique.

It provides complementary information to CRYSTAF data in the analysis of some complex resins.

### CRYSTAF-TREF

CRYSTAF and TREF techniques in the same hardware to obtain complete CCD information. CRYSTAF analyzes it in the crystallization cycle and TREF in the dissolution cycle.

The analysis of complex PP-PE combinations has been shown to require both TREF and CRYSTAF to unequivocally characterize unknown samples, due to the differences in the undercooling between both resins.

### CEF

Crystallization Elution Fractionation (CEF) is a approach to measure the Chemical Composition Distribution in polyolefins by combining CRYSTAF and TREF separation mechanisms. It is of special interest for high speed analysis.

CEF is a simple and reliable apparatus, requiring an injection valve, a column, a pump and an IR detector. The autosampler, attached to the CEF oven, takes care of samples dissolution in vials of 10 or 20ml. The instrument has the capability to analyze 50 samples a day with disposable glass vials and no supervision required.

*U.S. Patent 8,071.714 B2.*



## MOLAR MASS DISTRIBUTION (GPC/SEC)

### GPC-IR®

GPC-IR® is a reliable and fully automated 4D High Temperature Gel Permeation Chromatograph (GPC) dedicated to the characterization of polyolefins. It incorporates the best infrared (IR) detectors, with the add-on of providing composition information as well.

Two different infrared detectors are available: IR5 MCT, with outstanding sensitivity and stability to measure both concentration and composition (SCB/1000TC), and IR4, with the possibility of measuring carbonyls content as well. In addition, Polymer Char's Four Capillary Bridge Viscometer and a Multi-Angle Light Scattering (DAWN® HELEOS II™ from Wyatt Technology®), for the determination of the absolute molar mass and Long Chain Branching (LCB) study, can be coupled to the GPC-IR® system, becoming the most complete instrument for SEC analysis.

### GPC-QC

Solution designed for production plants, found under the *Quality Control* Section of this catalogue.

### GPC One® Software

Polymer Char's GPC One® Software platform has been developed with the leaders in the industry, to achieve all the goals demanded by GPC users nowadays, when the High Temperature GPC/SEC technique requires complex data processing that may depend on specific company procedures difficult to integrate in a closed software solution.

The GPC One® platform meets these above needs by integrating and processing all the detectors signals in a single environment.

This software is compatible with GPCs from other vendors through the interface Data Unit 200 by Polymer Char.

*Developed in 2008 with an American Chemical Company leader in Polyolefins.*

## SOLUBLE FRACTION MEASUREMENT

### CRYSTEX®

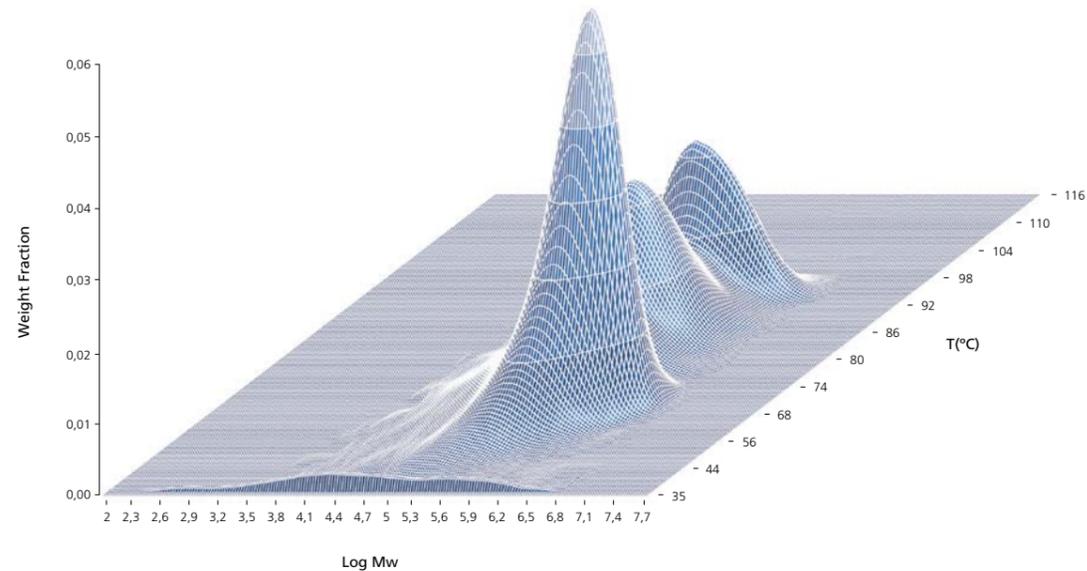
A CRYSTAF-based technology that automates the soluble fraction determination in polypropylene copolymers, usually known as "Xylene Solubles". The crystalline and amorphous fractions are separated through a dissolution crystallization temperature cycle within up to three closed stainless steel vessels. Developed with a Belgian Petrochemical Company in 1999.

### CRYSTEX® 42

A completely automated instrument for measuring the soluble fraction with an extended capacity for 42 samples. The instrument also quantifies ethylene content and intrinsic viscosity in the original sample, the crystalline and amorphous fractions. This TREF-based method is being embraced by the industry as a robust and reliable alternative to traditional gravimetric methods (ISO 6247 part B, ASTM D-5492), due to the dramatic reduction of analyst time and laboratory supplies, outstanding precision and the potential for multi-detection capabilities.

### CRYSTEX® QC

The same principles as CRYSTEX® 42 apply, but with one sample injection at a time. Solution designed for simple operation in production plants found under the Quality Control section of this catalogue.



## BIVARIATE DISTRIBUTION

### CFC

A fully automated Cross-Fractionation Chromatograph (CFC) for the analysis of the Bivariate Distribution in polyolefins (3D molar mass composition interdependence).

High resolution cross-fractionation of polyolefins is now made possible through Polymer Char's fully automated CFC instrument. Two dimensional distribution relating molar mass and composition variables is often required for comprehensive characterization of complex materials, and complete cross-fractionation is the only technique that determines it without any loss of information.

This compact and automated instrument fractionates the polymer according to crystallinity, following a TREF process (Temperature Rising Elution Fractionation), while the resulting fractions are continuously injected into the online GPC columns where a second fractionation, this time according to molar mass, is performed.

*Developed with a Japanese Chemical Company in 2006.*



## HIGH TEMPERATURE HPLC

### SGIC 2D

The SGIC 2D instrument performs a fractionation of the polymer according to composition by solvent gradient HPLC technique in adsorption mode followed by a second separation by Gel Permeation Chromatography (GPC/SEC) of the fractions eluted in the first mode. At the end of the analysis the two-dimensional distribution relating molar mass and composition is obtained.

The instrument is fully automated including all the sample preparation steps, and detection is performed by an infrared detector overcoming the limitations given by standard SGIC systems.

Polymer Char's analytical SGIC 2D instrument is a practical alternative to preparative fractionation methods, giving results in hours instead of days in an intrinsically safe setup.

### TGIC

The TGIC technique using carbon based adsorbents was developed by The Dow Chemical Company to characterize the composition distribution in polyethylene copolymers. This technique requires a cooling (adsorption) and a heating step (desorption) where elution takes place in a similar fashion to TREF or CEF and allows to extend the range of polymers to be analyzed onto the elastomers and other amorphous polyolefins, where it has been demonstrated to be more appropriate than techniques based on crystallization.

TGIC is performed in a practical and attractive way with a single solvent in a CEF instrument with an infrared detector, only requiring to replace the TREF column with a TGIC column.

## QUALITY CONTROL

### IVA - Intrinsic Viscosity Analyzer

High-throughput and fully automated instrument for the analysis of the intrinsic viscosity in polymeric materials. Up to 42 samples can be analyzed in a continuous process. The incorporation of an IR4 infrared detector avoids the need for accurate weighing and provides chemical composition information simultaneously.

### CRYSTEX® QC

A TREF-based instrument of simple operation that quantifies the amorphous fraction in polypropylene, one sample at a time, in only 2.5 hours. Manpower and analysis time are significantly reduced while precision is outstanding. The instrument also quantifies ethylene content and intrinsic viscosity in the original sample, crystalline and amorphous fractions.

### GPC-QC

A small, simple and robust GPC instrument for fast measurement of molar mass distribution in a production plant environment (start-ups, grade changes). It injects one sample at a time (no autosampler), and has an intelligent dissolution procedure to obtain MMD and chemical composition data in less than an hour. It is especially applicable to multireactor process resin control.



## PREPARATIVE FRACTIONATION

### PREP mc<sup>2</sup>

PREP mc<sup>2</sup> is a preparative instrument intended for fractionating polymers with no hot solvents handling by molar mass or by composition (TREF or CRYSTAF). Samples are put into the vessels and the fractionation is performed automatically according to the selected method conditions in less than 24 hours.

Molar Mass fractionation is based on the solvent interaction with the polymer chains through a solvent/non-solvent combination. Polydispersity of the resulting fractions can be very narrow.

*Developed with a German Chemical Company in 1996.*

### PREP C20

Polymer Char's new column-based preparative fractionation system is able to fractionate up to 20 grams of polymer depending on the sample difficulty. Initially designed for Polymer Char Fractionation Services Business Unit, it has been modified to become a commercial fractionation equipment as well.

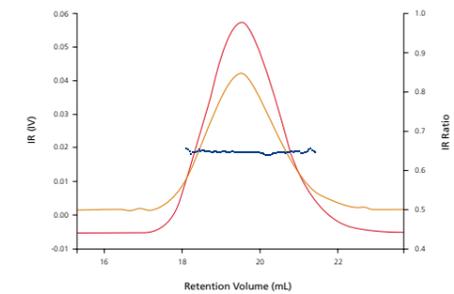


## INTEGRATED INFRARED DETECTION

### IR4

IR4 (above) is a dual wavelength infrared detector, which uses the principle of infrared absorption spectroscopy to measure the concentration and composition in polyolefins.

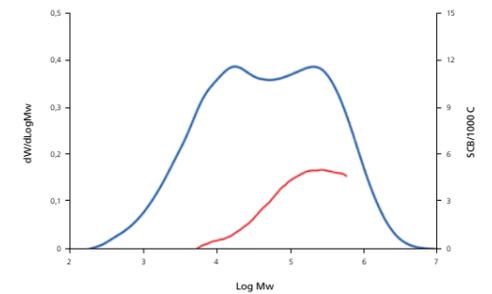
IR4 is integrated in the Polymer Char's instruments like GPC-IR®, CEF, CFC, CRYSTAF, TREF, etc.



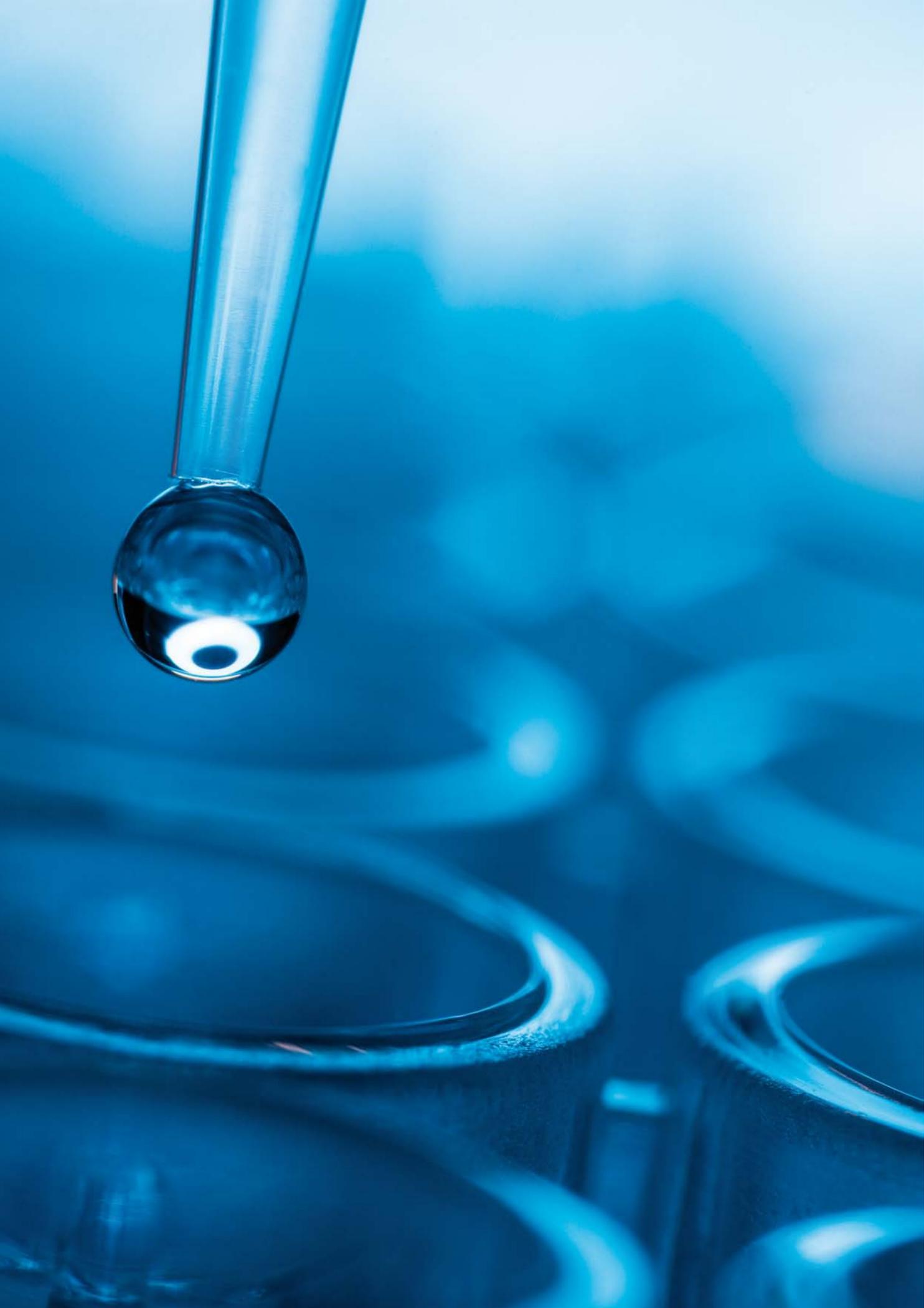
GPC-IR® with IR4 results of a Metallocene Polyethylene Resin

### IR6

The new IR6 detector provides outstanding sensitivity and baseline stability in concentration, composition and carbonyls signals even with low concentration values. It is an ideal detector in demanding techniques such as GPC-IR® or CFC for measuring very low number of branches in HDPE pipe resins since it is capable to distinguish differences of 1 branch per 1,000 atoms of carbon.



GPC-IR® with IR6 of a HDPE Resin



LabAID, our platform of solutions is meeting the ultimate needs in the laboratory with a series of accessories designed to facilitate the daily operations, allowing to better allocate time and resources to other more value-added tasks.

# Accessories

## Accessories by Title

- External Dissolution Oven (EDO).
- External Filtration System (EFS).
- Semi-automatic Sample Weighing.
- Solvent Handling Trolley (SHT).
- Polymer Standards for Calibration.



## ACCESSORIES

### External Dissolution Oven (EDO)

In a polyolefin characterization laboratory, sometimes there is a need for dissolving samples, either for testing the solubility of unknown materials in different solvents, separating some additives or performing other specific analyses.

A compact and efficient oven is offered for the external dissolution of samples with programmed temperatures and different levels of shaking. The system uses closed vials of 10 and 20 mL, compatible with Polymer Char instruments for convenience. This oven is a stand-alone version of the one used in the GPC-IR® autosampler, operated independently through its own temperature display and controls.

### Semi-automatic Sample Weighing

The process of weighing a large number of samples when using an autosampler can be speeded up by connecting a balance to the GPC-IR® system. The system calculates the amount of solvent to add to each vial based on the weight in order to achieve a target concentration. The information is transferred automatically to the instrument's run queue.

### External Filtration System (EFS)

Some applications require the materials to contain fillers and pigments that need to be removed prior to an analysis because they can damage the GPC columns and/or cause obstructions.

These additives of very small-particle size such as carbon black, easily make their way through the inline filters complicating the separation from the polymer matrix. There is the possibility of selecting a dedicated carbon black in-line filter but that would mean having to replace it more frequently. An external filtration apparatus has been especially designed for those cases in which one needs to frequently filtrate samples containing carbon black.

LabAID  
by Polymer Char

The only line of accessories specifically designed for a polyolefin characterization laboratory.

### Polymer Standards for Calibration

The GPC-IR® equipment requires some standards for calibration.

The **standard polystyrene** resins used for molar mass calibration are prepared in 10 mL vials ready to use in the GPC-IR® equipment. The kit includes 4 vials covering the whole range of molar masses used to characterize polyolefins (from 266 to 12,200,00 g/mol; 16 standards) with the appropriate concentration for one injection.

For chemical **composition calibration** or Short Chain Branching content, there is a kit containing 6 polyethylene resins with octene comonomer incorporated in different percentages (from 2.6 to 45.9 SCB/1000TC, 2g of each resin provided).

Also available, is the **Soluble Fraction PP Calibration Kit**, a set of reference PP and copolymers samples for calibration of amorphous fraction results in CRYSTEX® QC and CRYSTEX® 42.

### Solvent Handling Trolley (SHT)

The frequent transfer of solvents from the storage or distillation area to the laboratory, and waste transfer from the instruments to the disposal area is a tedious and hazardous task.

Polymer Char has developed a trolley incorporating two high-flow rate dispensing pumps, valves and connections to handle large solvent and waste reservoirs in order to help with those solvent-delivery operations. This way, the analyst can refill or empty the bottles in an efficient and comfortable way, reducing time, odors and eliminating any heavy physical work.





Polymer Char's full service Contract and Analytical lab is considered today a global reference in the area of polyolefin analysis, counting on the latest instrumentation technologies.

From Valencia, Spain, Polymer Char performs analysis to Clients from over 35 countries all around the globe.

# Analyses

## Separation Techniques

- Gel Permeation Chromatography (GPC/SEC).
- Crystallization Analysis Fractionation (CRYSTAF).
- Temperature Rising Elution Fractionation (TREF).
- Crystallization Elution Fractionation (CEF).
- Cross Fractionation Chromatography (CFC).
- Thermal Gradient Interaction Chromatography (TGIC).
- 2D Solvent Gradient Interaction Chromatography (SGIC 2D).
- Soluble Fraction measurement.
- Semipreparative Fractionation.
- Intrinsic Viscosity.
- Quality Control Solutions.
- Special Analyses.

### Analytical Services Business Unit

Polymer Char offers worldwide polyolefin characterization, fractionation and consulting services, addressed to the petrochemical industry as well as to academia and research institutes.

Today, laboratories investigating polyolefins in 35 countries subcontract analyses and expertise from Polymer Char's Spain-based lab.

Polymer Char's infrared detectors IR4 and IR5, fully dedicated to polyolefins, are used as concentration and composition detectors in all the analytical techniques.

Other detectors are also available in some techniques, such as IR5 MCT for HDPE resins, Viscometer or the Light Scattering HELEOS™ 8+ by Wyatt Technology®.

### Molar Mass Distribution (GPC/SEC):

- Gel Permeation Chromatography for Concentration and Composition using GPC-IR®, the most advanced technology in HT-GPC for polyolefins.
- GPC-QC analyses also available, specially suitable for UHMWPE polymers.

### Chemical Composition Distribution (CCD):

- Crystallization Analysis Fractionation (CRYSTAF).
- Temperature Rising Elution Fractionation (TREF).
- Crystallization Elution Fractionation (CEF).
- Thermal Gradient Interaction Chromatography (TGIC).

### Bivariate Distribution:

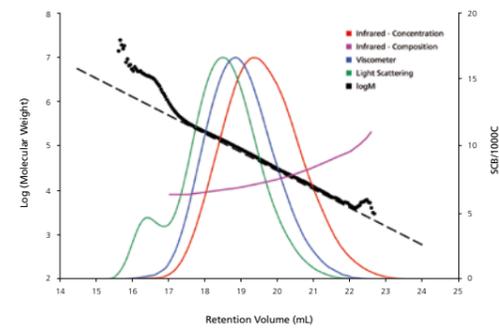
- Cross Fractionation Chromatography (CFC).

### High Temperature HPLC:

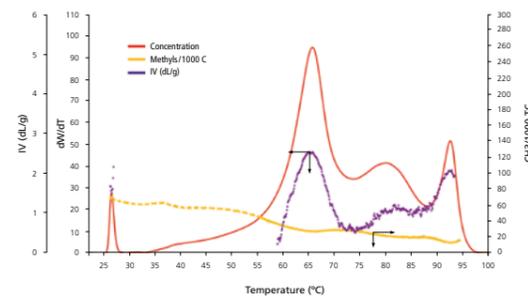
- Thermal Gradient Interaction Chromatography (TGIC).

### Preparative Fractionation:

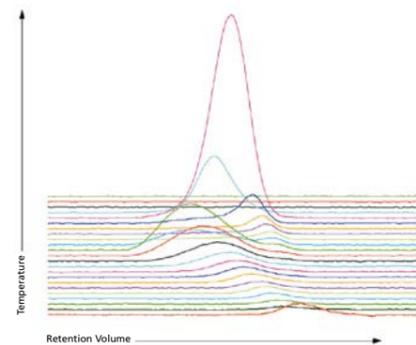
- Fractionation by TREF.
- Fractionation by CRYSTAF.
- Fractionation by Molar Mass.
- Large-scale Fractionation.



Polymer Char GPC-IR Triple Detection+Composition



Trimodal LLDPE sample analyzed by CEF with IR5 Concentration and Composition, and Viscometer Detectors



GPC/SEC chromatograms collected at 23 different fractionation temperatures, showing both the molar mass and the compositional heterogeneity of the analyzed PE blend



### Soluble Fraction Measurement:

- CRYSTEX®, CRYSTEX® QC and CRYSTEX® 42 analysis.

### Special Analysis:

- Special conditions analysis upon feasibility study.
- Intrinsic Viscosity Analysis for all polymers.

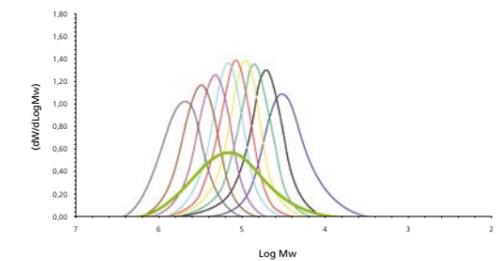
### Services Methodology at-a-glance

- All standard services fees can be found at [www.polymerchar.com/analytical\\_services](http://www.polymerchar.com/analytical_services)

- Public Institutes and Universities are granted with a globally fixed discount.

- Standard response time is 3 weeks. Priority service on-demand.

- A report by a specialized Chemist is submitted by e-mail after the analysis.



GPC analysis comparison of 9 fractions by molar mass

| CRYSTEX results for Xylene Solubles (%), IV and Ethylene content (%) of three different samples |                 |        |        |        |         |       |
|---|-----------------|--------|--------|--------|---------|-------|
| Description   | Parameter       | Data 1 | Data 2 | Data 3 | Average | Units |
| Sample 1  | IV whole (dL/g) | 3.01   | 3.02   | 3.02   | 3.02    | dL/g  |
|   | IV SF (dL/g)    | 3.66   | 3.70   | 3.69   | 3.68    | dL/g  |
|   | C2% whole       | 7.7    | 7.8    | 7.7    | 7.8     | %     |
|   | C2% SF          | 24.9   | 25.4   | 25.5   | 25.2    | %     |
|   | % CRYSTEX SF    |        |        |        | 17.05   | %     |
| Sample 2  | IV whole (dL/g) | 1.57   | 1.57   | 1.57   | 1.57    | dL/g  |
|   | IV SF (dL/g)    | 2.47   | 2.52   | 2.53   | 2.50    | dL/g  |
|   | C2% whole       | 5.9    | 5.9    | 5.9    | 5.9     | %     |
|   | C2% SF          | 12.2   | 13.1   | 13.2   | 12.8    | %     |
|   | % CRYSTEX SF    |        |        |        | 3.81    | %     |
| Sample 3  | IV whole (dL/g) | 2.32   | 2.32   | 2.32   | 2.32    | dL/g  |
|   | IV SF (dL/g)    | 5.01   | 4.9    | 5.2    | 5.04    | dL/g  |
|   | C2% whole       | 9.2    | 9.3    | 9.2    | 9.3     | %     |
|   | C2% SF          | 33.2   | 33.1   | 33.6   | 33.3    | %     |
|   | % CRYSTEX SF    |        |        |        | 9.81    | %     |



Leveraging a competitive advantage: Focus and Research.

With an annual investment of more than 20% of manpower resources in new developments for the characterization of PE and PP, our daily technical operations are mainly based on a continuous improvement spirit and an efficient and responsive service.

Research

#### Allowing Scientists to explore New Applications

Today, Polymer Char R&D and Analytical Teams keep investigating new analytical techniques and exploring innovative instrumentation and software capabilities in the field of microstructural characterization of polyethylene, polypropylene, and other types of polyolefins.

Tomorrow, some of these developments will probably be used by the world experts in polyolefin research, helping them to find out which and how properties can be improved in one of the most common materials in the 21<sup>st</sup> century.

### R&D Approach

As a technology company, Polymer Char is highly devoted to Research and Development activities. For more than 25 years the company has been investing annually around 20% of its manpower resources in R&D projects.

Thanks to this continuous dedication, today the company can provide the widest range of reliable and advanced instruments for polyolefin characterization.

In recognition of Polymer Char's technology, the company has received several awards, such as being considered one of the 50 Successful Companies in innovation in the Valencian Community or the innovation recognition in 2010 for its instrument GPC-IR® by C&EN Magazine (from the American Chemical Society).

Several multinational companies have worked together with Polymer Char in joint projects, such as Solvay, The Dow Chemical Company or Mitsubishi Chemical. Polymer Char also has close technical collaborations with R&D institutes and universities, such as the Fraunhofer Institute or the Institute for Polymer Research of the University of Alberta, among others.

Polymer Char laboratories in the Valencia Technology Park are considered today a worldwide reference, receiving every year scientists and technologists in the field of polyolefin analysis from all around the globe. With the various techniques to determine polyolefin microstructure, the whole range of Polymer Char instruments performs here analyses for entities in 35 countries.

Polymer Char has a close connection with the polyolefin industry, being its researchers frequently invited to give lectures in the main polymer research conferences and to contribute proactively by publishing scientific publications in the field.

With approximately 65% of its employees directly involved in R&D projects, Polymer Char's technical approach is closely aligned to its Mission: to become the leading-technology company in the field of polyolefin analysis.

### Quality Management

Polymer Char's philosophy is specially oriented to Quality Management. Each week, the Analytical, Engineering, and Manufacturing teams join to follow up the potential improvement areas within each R&D project, technology and lab practice.

Business practices, and specially the technical ones, such as those from the labs and manufacturing, are audited and reviewed monthly by an internal Quality Team. In addition, Engineering, Analytical, and Manufacturing departments are highly involved in several work-teams to ensure the Customer always receives the best quality product and service.

In addition to having most of its internal proceedings working according to universal quality management proceedings, in 2016, Polymer Char obtained the ISO 9001:2018 Certification.

In conclusion, Polymer Char's Quality Management policy honors its essence: Scientific Commitment and Customer-orientation.

# +20%

manpower resources dedicated to R&D.

# 35

countries where we provide analytical services.

# +25

years operating in the global industry, as the sole company fully dedicated to Polypropylene and Polyethylene characterization techniques.

# Pioneers

in analytical techniques such as CRYSTEX®, automated TREF and CFC, CEF, GPC/SEC with IR...

# 5<sup>th</sup>

most innovative instrument recognition to GPC-IR® by C&EN in its category in Pittcon in 2010.

# 4 of 5

top Global Fortune 500 Companies are Customers.

# 1 of 50

"Successful Companies in Innovation" in the Valencian Community.

# PO lab

considered as a global reference in technology, consulting in India, China...

# +65%

employees working on R&D projects.

# +8

instruments developed in collaboration with Customers.

# HT-GPC

market world leadership in technology and service.

# Active

R&D collaborations with Customers.

# W. Yau

Scientific Advisor on GPC/SEC since 2010.

# +25

countries supplied with our technologies in 5 continents.

# ISO

ISO 9001:2008 Certified and Quality Management Assurance.

# +5

scientific lectures per year.

# IR

technology leader for polyolefin analysis, guaranteeing the most liable results in concentration and composition measurement.

# +5

instruments developed in two years.



At Polymer Char we strive to be fast, thorough and efficient in our service and support.

Working on quick response, equipment reliability and automation, virtual instrumentation software, practical training programs, or a familiar service spirit, are just a few of the many challenges we face every day to succeed in our response.

# Service

## Key facts

- Highly automated systems.
- Modular equipment design.
- Easy maintenance.
- Intuitive and user-friendly software.
- Counting on the most technological and reliable OEM suppliers.
- All instruments share a similar hardware and software platform.
- Virtual Instrumentation Software for Remote Control access.
- User Training: UTM, Users Training Meeting.
- Analyst Training: ICPC Course on Separation Techniques.
- Warranty and Maintenance Services Plans available.
- R&D and Support Teams, Scientific Advisors and Official Distributors at Customer's disposal.

### Users Training Meeting

If you are a Customer or are going to acquire one of our instruments, and would like to learn more about Polymer Char techniques, to improve your knowledge about how to do preventive maintenance, the Users Training Meeting (UTM) is definitely the right program for you.

### UTM Objectives

The program is designed to answer questions such as:

- What are the basic polyolefin characterization techniques?
- What analytical instruments are available in the industry?
- How can I control the instrument?
- How can I control the software?
- How can I optimize my analysis?
- How should I interpret my results?
- How should I maintain the instrument?
- What other troubleshooting measures should I take into account?

### Aimed at

- Instrument Users, Analysts and Technicians.
- Laboratory Managers interested in learning more about Polyolefins.

### Course Agenda

The program may be focused on different topics depending on the instruments the attendees are interested in:

- Introduction to Polyolefin Characterization. General Techniques.
- Hardware and Software Overview. Maintenance Philosophy.
- Techniques Description: Manual Screen + Process Data + Results.
- Instrument Daily Operation.
- Control Software and Calculations Software.
- Results Understanding and Applications.
- Process Data Interpretation and Troubleshooting.

### Who should attend

When an instrument is acquired, a customized training is held in the customer's facilities. Nonetheless, it is highly recommended to combine both this training on-site and the Users Training Meeting.

Current Customers who have been using their instrument for long, may also find this program interesting as it will allow them to refresh their knowledge and have the latest information of this field.

### Dates and Venue

Depending on the demand, we organize the UTM once per year, in one of the following cities:

- Beijing, China. 1-2 days.
- Houston, TX, U.S.A. 1-2 days.
- Shanghai, China. 1-2 days.
- Valencia, Spain. 2-3 days.

Users may have a special interest in the Course held in Valencia, as they have at their disposal the whole range of instruments, which makes practical sessions more effective and increases Customers' comprehension on the instruments and techniques.

A Short Course in Polyolefin Microstructural Characterization Techniques may be held in the same venue. (Please see concrete edition program to confirm details).



### Designed to be reliable.

Minimizing the possibilities of system failure.

### Training for preventing.

Emphasizing on training to prevent malfunctioning events.

### Responding.

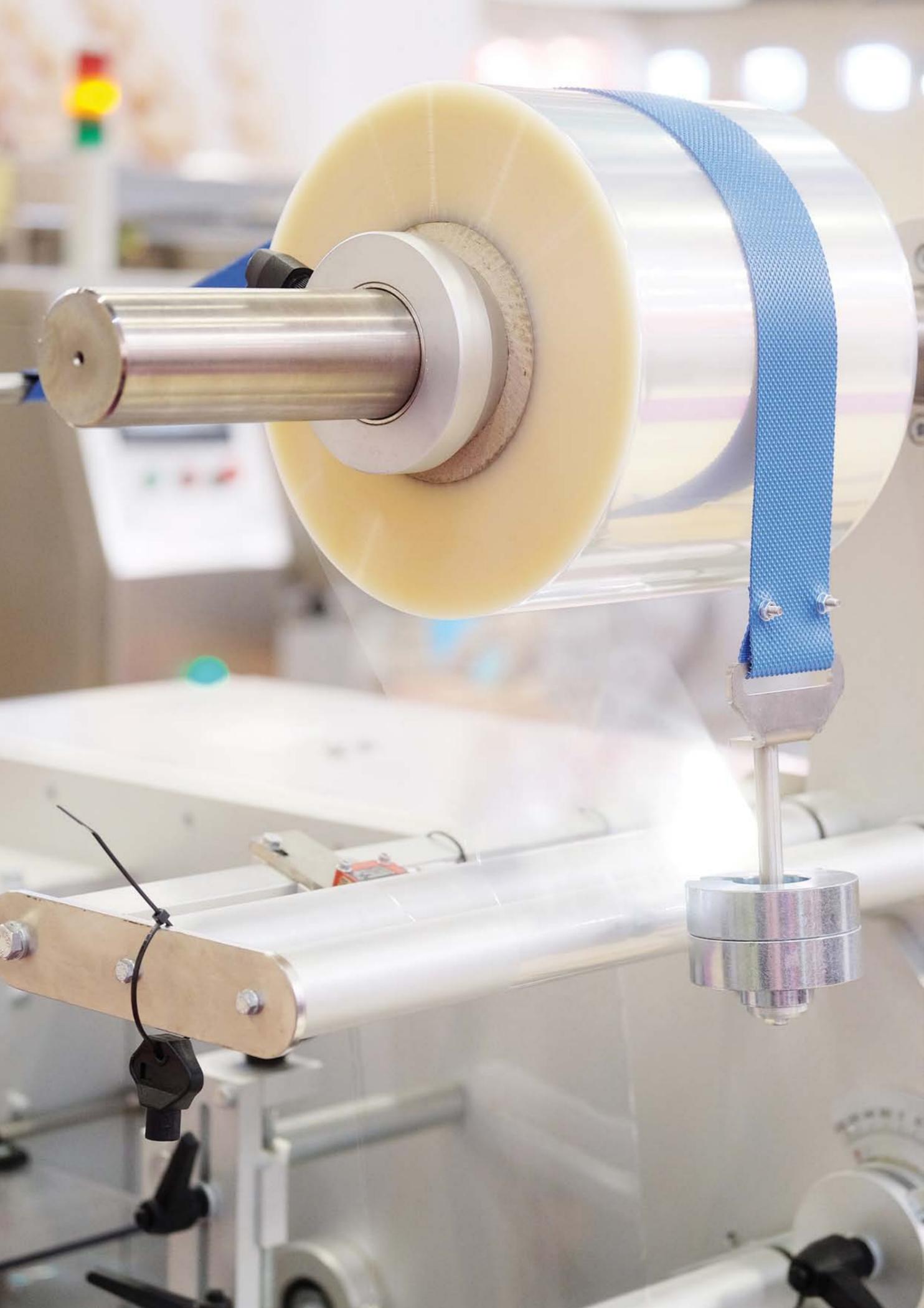
Striving to be fast, thorough and decisive in our response.

### Customer Support Policy

Polymer Char is aware that reliability and ease of maintenance of the instrument are of major importance for the Customer, mainly because they work at high temperatures and require complex solvents.

To ensure the best performance of the systems provided, Polymer Char's Service philosophy is mainly based on three pillars: minimize the possibilities of malfunctioning events, time of response and the safety risks for the customer.

Furthermore, a thorough training is received by the Users to become capable of both mastering the instrument and carrying out preventive maintenance tasks.



At Polymer Char, we are proud to have a broad and diversified Customer base throughout the petrochemical industry.

Our technologies are supplied to leading multinational corporations, most of them heading the Fortune 500 list and being renowned brands in the petroleum and chemical industries.

# Industries

## Markets served

Polyolefins are among today's most used polymers. Despite their simple chemistry, with only carbon and hydrogen atoms, they still possess a complex microstructure. Here is where Polymer Char provides expertise and solutions across several industries:

- Polymer Producers.
- Polymer Processors.
- Government Laboratories.
- Contract Research Institutes.
- Analytical and Testing Labs.
- Academia.
- Instrument Manufacturers.
- Tire and Rubber Manufacturers.

### Polymer Producers and Processors

Polymer Char supplies most of its technologies to manufacturers and processors of polymers, and more specifically, of polyolefins.

Several of them, key players in the polymer industry, have today dozens of Polymer Char equipments, and have trusted for years on its expertise and service.

### Government and Contract Research Labs

A significant part of Polymer Char instruments are installed in Government and Contract Research laboratories, which do not produce polymers but play a key-role in the scientific research field, working in many cases together with Polymer Char team to develop and improve the analytical techniques used on their equipments.

### Academia

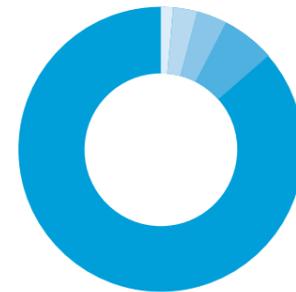
Polymer Char also provides instruments to several universities which emphasize their research in the area of polymer analysis. These universities are mainly located in North America, Western Europe and Middle East.

### Instrument Manufacturers

Among Polymer Char Customers there are a couple of instrument manufacturers as well. These companies are based in the United States, Germany and Japan, although their instruments are marketed worldwide.

### Other Industries

Polymer Char provides as well to other large corporations that are not essentially petrochemical companies but need to develop new applications based on polyolefin materials or to improve properties of their existing products. This is the case of Tire and Rubber manufacturers, Metals and Materials Engineering companies.



- Petrochemicals
- Academia
- Government Organizations
- Instrument Manufacturers
- Contract Research Organizations



### Distribution Network

**Brazil:**  
dpUNION Instrumentação Analítica e Científica.

**Germany and Switzerland:\***  
PSS, Polymer Standards Service GmbH.

**India:**  
LabChrom Scientific LLP.

**China:**  
Beijing Yiluda Electromechanical Equipment Co.

**Japan:**  
SDMS Corporation.

**South Korea:**  
HI Corporation.

**Southeast Asia Region (Singapore, Malaysia, Indonesia and Thailand):**  
LMS Instruments Co. Ltd.

\* Market and service GPC-IR\* instruments.





Polymer Char, together with our global network of partners and distributors, supply, train, and support Customers worldwide.

Nowadays, we have equipments installed in leading petrochemical and government research labs in over 25 countries across America, Europe, Africa, Middle East, and Asia Pacific.

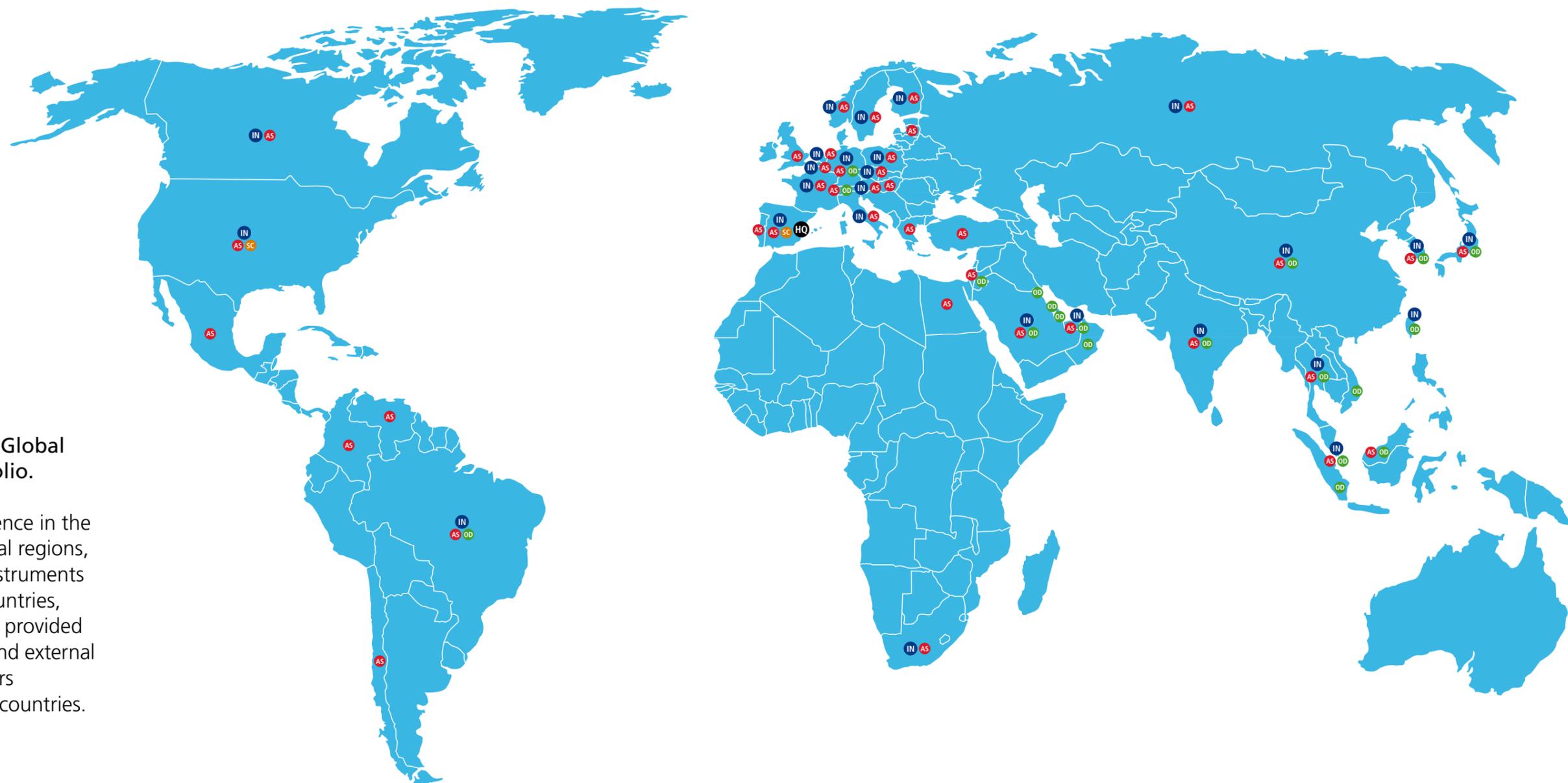
Global

#### Outline

Polymer Char's equipments are present today in over 20 countries around the world, distributed among North America, Latin America, Europe, Africa, Middle East and Asia Pacific.

The main regions supplied are North America, West Europe and other traditional petrochemical regions in Asia such as Japan, China, or South Korea.

However during the last decade, Polymer Char technologies have caught the attention of emerging economies such as Brazil, Middle East Gulf Countries and South and East Asia, where India, and Thailand.



## Well-diversified Global Customer Portfolio.

With strong presence in the core petrochemical regions, today we have instruments installed in 27 countries, analytical services provided to 37 countries, and external Official Distributors established in 18 countries.

### IN Instruments installed

|                |                      |
|----------------|----------------------|
| Austria        | Norway               |
| Belgium        | Poland               |
| Brazil         | Russia               |
| Canada         | Saudi Arabia         |
| China          | Singapore            |
| Czech Republic | South Africa         |
| Finland        | South Korea          |
| France         | Spain                |
| Germany        | Sweden               |
| India          | Taiwan               |
| Italy          | Thailand             |
| Japan          | United Arab Emirates |
| Malaysia       | United States        |
| Netherlands    |                      |

### AS Analytical Services provided

|                |             |                      |
|----------------|-------------|----------------------|
| Austria        | Greece      | Saudi Arabia         |
| Belgium        | Hungary     | Singapore            |
| Brazil         | India       | South Africa         |
| Canada         | Israel      | South Korea          |
| Chile          | Italy       | Spain                |
| China          | Japan       | Sweden               |
| Colombia       | Malaysia    | Switzerland          |
| Czech Republic | Mexico      | Thailand             |
| Egypt          | Netherlands | Turkey               |
| Estonia        | Norway      | United Arab Emirates |
| Finland        | Poland      | United Kingdom       |
| France         | Portugal    | United States        |
| Germany        | Russia      | Venezuela            |



Celebrated in Houston, Valencia and Shanghai, the International Conference on Polyolefin Characterization (ICPC) has become the world meeting point par excellence for Researchers from both Industry and Academia.

**We hope to see you in Valencia 2020.**

ICPC

#### ICPC at-a-glance

|               |   |
|---------------|---|
| Venues:       | Houston, Valencia and Shanghai.   |
| Regularity:   | Biannually, since 2006.   |
| Lectures:     | 35 (7 <sup>th</sup> ICPC).  |
| Posters:      | 35 (7 <sup>th</sup> ICPC).  |
| Attendees:    | 145 (7 <sup>th</sup> ICPC).   |
| Countries:    | 21 (7 <sup>th</sup> ICPC).  |
| Sponsors:     | The Dow Chemical Company, Braskem, Exxon Mobil, Chevron Phillips, and Borealis. |
| Next Edition: | Valencia, Spain, 2020.  |
| Web-site:     | <a href="http://www.icpc-conference.org">www.icpc-conference.org</a>            |

### ICPC Conference

The International Conference on Polyolefin Characterization (ICPC) was born in 2006 to satisfy the need for an international conference specifically focused on polyolefin characterization. Until then most of the existing polyolefin conferences dealt with catalyst and reaction engineering.

The ICPC Conference covers different aspects on Polyethylene and Polypropylene molecular architecture characterization, including molar mass distribution, comonomer incorporation and distribution, long chain branching, crystallinity and rheological properties.

Being organized by Polymer Char, ICPC previous editions have been celebrated in Houston, Valencia and Shanghai, covering this way the whole world map and becoming a truly unique international conference on the field of polyolefin characterization.

With attendees coming from over 25 countries, around 35 lectures and 40 posters in the last editions, ICPC unifies the participation of researchers from both industry and academia throughout all the continents, becoming the only platform for learning, sharing and networking.

The ICPC experience is complemented with a posters session, a short course on analytical techniques, commercial presentations, networking cocktails and an exhibition area.

The conference is targeted to Researchers working for Polyolefin Producers and Processors, Contract Research Organizations, Government and Academic Research Laboratories, Analytical and Testing Labs and Instruments Manufacturers.

### Editions

|                      |                 |      |
|----------------------|-----------------|------|
| 1 <sup>st</sup> ICPC | Houston, TX     | 2006 |
| 2 <sup>nd</sup> ICPC | Valencia, Spain | 2008 |
| 3 <sup>rd</sup> ICPC | Shanghai, China | 2010 |
| 4 <sup>th</sup> ICPC | Houston, TX     | 2012 |
| 5 <sup>th</sup> ICPC | Valencia, Spain | 2014 |
| 6 <sup>th</sup> ICPC | Shanghai, China | 2016 |
| 7 <sup>th</sup> ICPC | Houston, TX     | 2018 |

### Scientific Committee

#### Dr. Benjamin Monrabal

Polymer Char, Spain  
*Co-founder.*

#### Dr. Colin Li Pi Shan

The Dow Chemical Company, U.S.A.  
*Co-founder.*

#### Prof. João Soares

University of Alberta, Canada  
*Co-founder.*

#### Prof. Minoru Terano

Japan Advanced Institute of Science and Technology (JAIST), Japan

#### Prof. Dujin Wang

Institute of Chemistry, Chinese Academy of Science (ICCAS), China

### Technical Program

Separation and Fractionation.  
Molecular Structure and Properties.  
Morphology.  
Thermal analysis.  
Rheology.  
Spectroscopy.



### Sponsors

ICPC editions have been supported by many leading companies such as:

Agilent Technologies  
Anton Paar  
Braskem  
Borealis  
Chevron Phillips Chemical  
DPI, Dutch Polymer Institute  
ExxonMobil Chemical  
Fraunhofer Institute  
Freeslate  
Jordi Labs  
LCGC, Advanstar Group  
Lyondellbasell  
Malvern Instruments  
Ningbo Dacheng Advanced Material Co.  
Petro Industry News  
Polymer Char  
Polymers Journal  
Postnova Analytics  
Progression Inc.  
PSS, Polymer Standards Service  
SABIC  
SCG Chemicals  
Shenhua Ningxia Coal Industry Group  
Tosoh Bioscience  
The Dow Chemical Company  
Tosoh  
Waters  
Wyatt Technology

### Countries Represented

|                |                |
|----------------|----------------|
| Austria        | Poland         |
| Belgium        | Russia         |
| Brazil         | Saudi Arabia   |
| Canada         | Singapore      |
| China          | South Africa   |
| Czech Republic | South Korea    |
| Estonia        | Spain          |
| Finland        | Sweden         |
| France         | Switzerland    |
| Germany        | Thailand       |
| India          | U.A.E.         |
| Italy          | United Kingdom |
| Japan          | U.S.A.         |
| Mexico         | Venezuela      |
| Netherlands    |                |





## Meeting our Customers' expectations on Service, is our major corporate objective.

During the last 25 years, Polymer Char's philosophy on instrumentation development has been strongly focused on reliability and continuous improvement to overcome the historical maintenance problems that usually arise when using solvents at high temperature.

Polymer Char has been optimizing equipment performance and minimizing downtime through meticulous designs and rigorous internal quality and testing processes. As a result, its instruments have become robust and are being successfully used today all around the world.

We are committed to supporting Polymer Char instruments with efficient remote and on-site service, and offering our Customers a close collaboration to ensure the highest performance of the equipment and the quality of analysis results provided.

For more information about our Service and Support response, Preventive Maintenance Plans, Warranty or any suggestion you may want to share with us, please do not hesitate to contact us at [support@polymerchar.com](mailto:support@polymerchar.com), we want to know more about it.



[www.polymerchar.com](http://www.polymerchar.com)

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