### Schedule

<table>
<thead>
<tr>
<th>Date</th>
<th>Course Title</th>
<th>Instructor</th>
<th>Code</th>
<th>Fee</th>
</tr>
</thead>
<tbody>
<tr>
<td>23-24 October 2017</td>
<td>Rubber Compounding Principles</td>
<td>Dr. Hans-Joachim Graf</td>
<td>ER-17-1</td>
<td>950 €/Person</td>
</tr>
<tr>
<td>23-24 October 2017</td>
<td>Rubber Rheology: Principles &amp; Practice</td>
<td>Instructor: Henry Burhin</td>
<td>ER-17-2</td>
<td>750 €/Person</td>
</tr>
<tr>
<td>25 October 2017</td>
<td>Rubber Mixing Plant: Design &amp; Layout</td>
<td>Instructor: Bruno Milanese</td>
<td>ER-17-3</td>
<td>750 €/Person</td>
</tr>
<tr>
<td>25 October 2017</td>
<td>Compound Formulation - Optimization &amp; Case Studies</td>
<td>Instructor: Dr. Hans-Joachim Graf</td>
<td>ER-17-4</td>
<td>950 €/Person</td>
</tr>
<tr>
<td></td>
<td>(Graf Compounder Software Included)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26 October 2017</td>
<td>Rubber Vulcanization – Science and Practice</td>
<td>Instructor: Prof. Robert Schuster</td>
<td>ER-17-5</td>
<td>750 €/Person</td>
</tr>
<tr>
<td>26 October 2017</td>
<td>Rubber Injection Molding</td>
<td>Instructor: Dr. Hans-Joachim Graf</td>
<td>ER-17-6</td>
<td>950 €/Person</td>
</tr>
<tr>
<td>27 October 2017</td>
<td>Performance in Silica/Silane Technology</td>
<td>Instructor: Prof. Robert Schuster</td>
<td>ER-17-7</td>
<td>750 €/Person</td>
</tr>
<tr>
<td>27 October 2017</td>
<td>Adhesion of Rubber</td>
<td>Instructor: Dr. Hans-Joachim Graf</td>
<td>ER-17-8</td>
<td>750 €/Person</td>
</tr>
</tbody>
</table>
Rubber Compounding Principles

(Instructor: Dr. Hans-Joachim Graf) (Schedule: 09.00-17.00 hrs)

More than 50% of rubber manufacturing cost is contributed by input raw material prices. Additionally the rubber compound influences processing costs as well as product quality. Rubber compound formulation design is hence a multi-faceted challenging art, not only because of the number of ingredients employed, but also its influence on processing and product service performance quality. The compounder has to be fully aware of the processing behaviour of the compounds during manufacturing and service performance requirements. Design guides specify methods and tools for compound formulation design and procedures to be adopted from the initial laboratory evaluation to bulk production. This enables the compounder to have total control to consistently achieve the design targets. Useful selection criteria will be reviewed based on physics, chemistry and engineering principles necessary for more advanced compounding work. This seminar will submit detailed knowledge, what a compounder needs to know about raw materials, their action in the compound and Influence in rubber manufacturing. The influence of crosslinking and accelerator systems on compound performance is discussed. Briefly, this course outline includes:

- Review of Formula Design;
- Polymer Selection
- Oil / Filler and its effect on performance
- Accelerator Systems – Solubility of Accelerators
- Relation of Crosslinking System on Performance,
- Ingredient Property Relations,
- Special Applications
- Nonlinear Visco-Elasticity
- Good Testing Practices

Rubber Rheology – Principles & Practice

(Instructor: Henry Burhin) (Schedule: 09.00-17.00 hrs)

The understanding and optimization of rubber processing requires a fundamental understanding of the rheological behavior of rubber and their compounds. Rubber compounds are essentially developed to meet the required vulcanize properties. This course gives an overview of the basic rheological properties and their measurement techniques. This course covers practical aspects of rheological results and interpretation of properties to assess and optimize processing such as milling, extrusion, molding etc. This course is suitable for compound developers, R & D team and Quality control in the rubber processing. Briefly, this course outline includes:

- General Concept of Material Properties
- Polymer Description and Rheological Properties
- Shear type Testing
- Dynamic Mechanical Analysis
- Effect of Processing/Measurement Conditions on Rheological Properties
- Effect of Material Characteristics on Polymer and Compound Rheology
- Effect of Strain on Rubbers and Compound Rheology
- General lay out and features of main equipment
- Polymer Selection
- Relation of Crosslinking System on Performance,
- Ingredient Property Relations,
- Special Applications
- Nonlinear Visco-Elasticity
- Good Testing Practices

Rubber Mixing Plant - Design & Layout

(Instructor: Bruno Milanese) (Schedule: 09.00-17.00 hrs)

Mixing Plant Line for rubber parts can be designed in different ways compared to tires. This seminar is focusing on selection and criteria of equipment required and layout of a rubber mixing line to operate a plant efficiently. Whereas a compounding line for production of tires is quite the same for most of tire producers, a compounding line for technical rubber goods can be designed in many different ways because of the wide range of recipes to be produced. Flexibility and easy access to the equipment is a must, as well as efficient cooling of the compound. Surprisingly, shape of rotors is of much less importance than normally considered. This course is suitable for both technical and non-technical people at rubber compounders. Briefly, this course outline includes:

- Targets of compounding line for tires vs. compounding line for technical rubber goods (TRG)
- General lay out and features of main equipment
- Internal Mixer: forces acting inside the mixing chamber, deformation of rotors
- Design of dust stop seals
- Considerations about friction ratio between tangential rotors and their impact on rotor deformation
- Impact of rotor deformation on dust stop seals
- Internal Mixer: tangential vs intermeshing rotors: some consideration about heat transfer
- Comparison between continuous and discontinuous process and consequences about rotor shape
- Downstream the Internal Mixer: roll mill vs. twin screw extruder

Rubber Compounding Formulation Optimization & Case Studies.

(Instructor: Dr. Hans-Joachim Graf) (Schedule: 09.00-17.00 hrs) (Delegates will receive Graf Compounder Software)

This course is designed for rubber compounders with experience. The focus is on good practices in development and optimization of compound with various case studies. The tools needed to resolve problems quickly and finding solutions much faster will be demonstrated. At the end of this seminar the participant should be able to take advantage of such available tools and adopt them in his/her daily routine and strategic work. Compounding methods and tools are illustrated, demonstrated and practised in workshop mode at the end of this seminar. All what is learned should enable the compounder to select sufficient methods under consideration of the difficulty and size of the project he is working on. Specifically this knowledge enables the compounder to stay ahead of his responsibility to control all cost aspects in rubber manufacturing, which requires such engineering techniques and tools. Briefly, this course outline includes:
Briefly, this course outline includes:

- Process of curing
- Reactivity of rubbers and curing systems
- Curing systems
- State of cure
- Cure process (kinetics)
- Sulfur curing (accelerators, activators, retarders, synergistic effects)
- Influences on reversion (curing system, rubber matrix, filler, processing)
- Peroxide Cure
- Metal oxide, resins,
- Cure packages
- Influence on standard physical properties
- Influence on ultimate properties
- Life time
- New Curing Systems

Rubber Injection Molding

Instructor: Dr. Hans-Joachim Graf  (Schedule: 09.00-17.00 hrs)

Injection Molding of Rubber is a multi-parameter process. Machine, Mold and Material interact and effect each other. This course will provide an understanding that the participant gets the ability to manage such a process. After an introduction of the injection molding machine, followed by a detailed description of the plastification units and their function and influence on the operation, a process model is provided. This model leads to experiments, which allow to construct an operating window, which is a tool to govern the process. Principles of mold layout and compound design with special regards to rheology is discussed. The participant will learn how this triangle can be understood and handled to achieve a stable manufacturing process. As a precondition, the molding machine must provide all necessary functions, therefore guidance, how to access the molding machine is discussed. We all see still defects on molded rubber parts, which make troubleshooting necessary. The course is completed with a discussion of some specific newer molding techniques and developments. Briefly, this course outline includes:

- Introduction to Molding of Rubber
- Rubber Injection Molding Machine
- Injection Molding Process
- Injection Mold Design
- Compounds for Injection Molding
- Assessment of an Injection Molding Machine
- Troubleshooting in Rubber Injection Molding
- New Developments in Rubber Injection Molding

Performance in Silica/Silane Technology

Instructor: Prof. Robert Schuster  (Schedule: 09.00-17.00 hrs)

The training is designed to provide an overview on filler reinforcement in general and the efficacy of the silica/silane technology in particular. With the implementation of silica in the tire technology (green tire) the tire properties have been successfully improved with respect to rolling resistance and wet grip. This leads directly to significant reductions of fuel consumption and safe driving at higher speed. Key parameters to the improvements are the dispersion of polar precipitated silica in non-polar rubber blends (BR/SBR and BR/SBR/NR) and the chemical coupling of silica to rubber chains. This two essential steps require the use of silanes to modify the surface of silica particles that way that interparticle interactions are minimized and, in addition, that chemical bonds between polymer and filler are established. Details about silanization with different silanes (mono- and difunctional) under different mixing conditions and temperature regime, the degree of silanization, the impact on silica dispersion and dynamic mechanical as well as ultimate properties will be presented. Briefly, this course outline includes:

- Classes of Silica
- Manufacturing of Silica
- Characterization of Filler Particles
- Grades
- Incorporation and Dispersion of Silica
- Flocculation of Silica in Compounds
- Methods to measure Dispersion
- Technical Mixing Procedures
- Curing silica compounds
- Fracture Mechanical Features
- Functional Polymers for Silica Compounds
- Properties of Silica Compounds
- Comparison with CB and other Fillers
Reinforcing elements are widely used in rubber parts for the automotive and construction industry. There are a few principles, which are supported scientifically and technologically. After an introduction into the principles of adhesion, manufacturing of rubber metal parts are discussed from metal preparation to moulding process is discussed. A troubleshooting guideline is provided based on these principles. Rubber to rubber, rubber to TP/TPE, or rubber to fabric/fibres requires differing process mechanisms – even so, these mechanisms share certain aspects and similarities which are discussed in this seminar. The participant will be exposed in this seminar to knowledge which governs almost all aspects of bonding. With the in depth understanding of the principles and how they apply to daily operation in rubber reinforcement participants should have an enhanced ability to develop a solution for most rubber bonding problems. Briefly, this course outline includes:

- The physics and chemistry of adhesion
- Rubber to metal adhesion an manufacturing
- Process considerations moulding rubber to metal parts
- Adhesion testing and troubleshooting
- Technology of rubber to rubber adhesion
- Rubber to Plastics (TP/TPE) adhesion
- Manufacturing aspects of two component parts
- Chemistry of Rubber to fabric / fibres bonding

**Instructors**

**Robert H. Schuster** studied organic and physical chemistry. After receiving his PhD in Freiburg (Germany) he joined in 1984 the German Institute of Rubber Technology (DIK) in Hannover. As the director of DIK (1991–2011) he was involved in worldwide research projects concerning mixing, processing, vulcanization, rubber – filler interaction, new nanocomposites, recycling and environmental issues. Since 1995, R. H. Schuster is Professor at the University of Hannover. He is the author of three books and more than 450 articles. For his distinguished contributions to Rubber Science and Technology he received the “Carl Harries” Medal from the German Rubber Society (DKG) and the “Melvin Mooney” Award from the ACS Rubber Division. Currently Robert H. Schuster is foreign expert at the EVE Research Institute in Qingdao (China).

**Mr. Henri G. Burhin** is presently Consultant for rubber industries and working with TA Instruments. He retired from Alpha Technologies (former Monsanto Instrument and Equipment). His previous responsibility was application research for the Monsanto Rubber Chemical group. His area of expertise is Polymer testing with elastic property measurements. This includes both plastics and rubber whether as pure materials or fully compounded. In his career in Monsanto/Alpha Technologies/ Dynisco, he technically supported the sales organization with special emphasis on rheological tools at demanding customers such as the major tire manufacturers or polyolefin multinational suppliers. He also participated in the latest development on the RPA2000 instrument towards higher productivity, sensitivity, accuracy and novelty. He acquired a wide experience in non-linear viscoelasticity, also quoted as “FT-Rheology”. He has been working in close collaboration with the UCL (Université Catholique de Louvain) Belgium in the polymer department for seven years working on thermoplastics, composites and Pre-Preg and Nano fillers. He holds 2 patents and several papers and has been speaker at several international conferences around the world. He was Application Specialist for all Alpha Technologies product range and Dynisco POLYTEST for Europe/ Africa, Asia and Indian sub-continent area. He is graduated in chemistry.

**Dr. Hans-Joachim Graf** has over thirty years’ experience in the rubber industry. He was first with manufacturing companies for pharmaceutical and technical rubber parts. He then joined DESMA a manufacturer of Rubber Injection molding and polyurethane shoe machines responsible for process development, followed by RheinChemie as senior manager of material developments for rubber industry. After Cooperstandard Automotive (CAN), division of profile extrusion, as a director of materials he is today with WOCO (GE), a manufacturer of injection molded parts in charge for material development and process design. Mr. Graf has authored over 60 publications and paper presentations and invented more than 15 patents. He has given a rubber technology course for graduates at University of Waterloo and is teaching courses in recipe design and industrial bonding at University of Hannover (GE) continuing education department. He is a member of the American Chemical Society, Deutsche Chemische Gesellschaft and Deutsche Kautschuk Gesellschaft. He received his diploma degree from University of Mainz and his doctorate in polymer chemistry from University of Freiburg, both Germany. During DKT’12 (German Rubber Conference 2012) he was awarded with the Erich-Konrad Medal of the DKG (German Rubber Society).

**Bruno Milanese** with more than 35 years professional experience, Bruno Milanese worked with mixing machinery suppliers POMINI, FARREL and Meccaniche Moderne. His work experience involved with engineering and commissioning of mixing rooms for the rubber industry, both for tyre industry and for technical rubber goods around the world. Since 2004, he has been providing technical advisory services related to rubber mixing.

**Venue**

**Bilderberg Garden Hotel**
Dijsselhofplantsoen 7, 1077 BJ, Amsterdam The Netherlands
Accommodation: 179 €/night + taxes

**Contact:** Ms. Lucie Ludema
**Tel:** +31 (0)20-5705655
**Email:** Garden.Banquet@bilderberg.nl

**To register, please contact**

**TechnoBiz Europe (HJG Consulting)**
Josef Leistenschneider Strasse 27 63628 Bad Soden – Salmünster GERMANY
**Tel:** +49 (0)151 2000 6394 **FAX:** +49 (0)3222 152 0721
**E-Mail:** graf.hans-joachim@t-online.de / technobiz.europe@gmail.com