

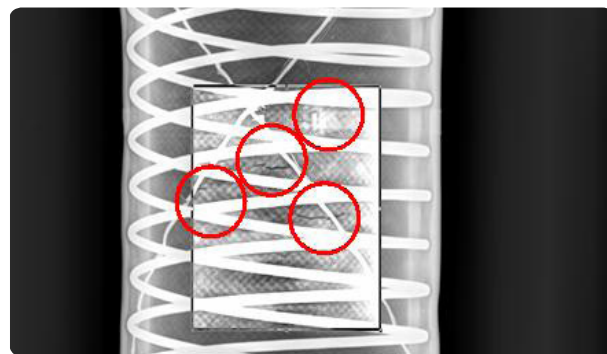
**Fourier Transformed Infrared Spectrometry (FTIR)**  
Can e.g. be used to identify materials and impurities.

**Oxidation Induction Time (OIT)**  
Is used for evaluation of antioxidants in polymer materials and their expected lifetime. Poor or insufficient antioxidants can lead to rapid yellowing or decomposition of the material.

**Density and viscosity analysis**  
Used e.g. in quality control.

**Mechanical testing**  
We conduct accredited tensile, compression and shear tests as well as three and four-point bend testing on plastic and composites. We also have a number of special apparatuses for measuring the creep properties of plastic and fibre composites.

**Ultrasound and X-ray analysis**  
Can be used to show the structure of composite materials and reveal interior faults and damage that are not yet visible externally. For example, one can reveal interior breaks in windmill blades, pipes and hoses.



*X-ray picture of reinforced tubing, revealing otherwise invisible cracks*

**Special assignments**  
When standard testing methods and techniques are not sufficient, or when solutions are required for especially complicated problems, just ask us. In such cases, creative thinking and advanced equipment are the answer. FORCE Technology has over many years helped clients with special assignments and can therefore customise tests that are somewhat beyond the usual.

**Research and development**  
FORCE Technology takes part in a number of national and international research and development projects. Most of the development projects are undertaken in cooperation with Danish and foreign companies and research centres. The goal is partly to advance technological development and partly to maintain a high level of knowledge among our staff for the benefit of our customers and collaborators.



*We analyse and advise about polymers*

**Hardness testing**  
Used, for example, to determine whether rubber gaskets become harder – thus less elastic – when exposed to heat or other influences during use.

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Plastics, Composites and Surface characterisation



## Polymer Technological Consultancy



### Plastic is used everywhere

Plastic and elastomer materials are used by our modern society in everything from medicine packaging to large pipe constructions. The breakdown, degradation and disintegration of a large number of these materials can have disastrous consequences for the product and the user. Such material defects can also have severe financial consequences for all parties involved.

Material failures can be avoided, provided that the necessary polymer chemistry expertise is applied. Moreover, it is often possible to find the cause of damage in order to avoid future damage.

### Consultancy and analysis

FORCE Technology is a partner for highly qualified consultancy on plastic and elastomer materials. We have at our disposal a wide array of analysis and testing methods that can be used as documentation and verification of theories.

### Partner for everyone

Our solutions are practical and application-oriented. Everyone who uses or produces plastic, elastomer, paints or glue can find an advantage in using FORCE Technology as a partner:

- As a producer, it is important to make good products that attain the quality required of them. Good quality leads to satisfied customers and is part of increasing business.
- As a user of plastic materials, it is important to employ the proper materials and joining methods. With the proper choice of materials one can avoid cost-heavy damage and production stoppages.
- Changing solvents or materials may result in a better work environment and more environment-friendly products.





Polymer granulate

### Choice of materials

To obtain the desired characteristics for a product, the choice of materials is critical. FORCE Technology has a lot of experience in choosing materials and we have a broad spectrum of analytical equipment at our disposal.

FORCE Technology offers the following services:

- Advice on plastic materials, elastomer, paint and glue, with respect to durability for a given application
- Optimisation of gluing, including types of surface and glue
- Advice on packaging of, for example, pharmaceuticals, foodstuffs and chemicals
- Environmentally appropriate and economical choices of plastic materials and solvents
- Advice on painting to protect metal, wood, plastic and concrete
- Advice on plastic coating of metal
- Advice on choice of materials for chemical protection gloves and suits
- Advice on production plant gaskets.

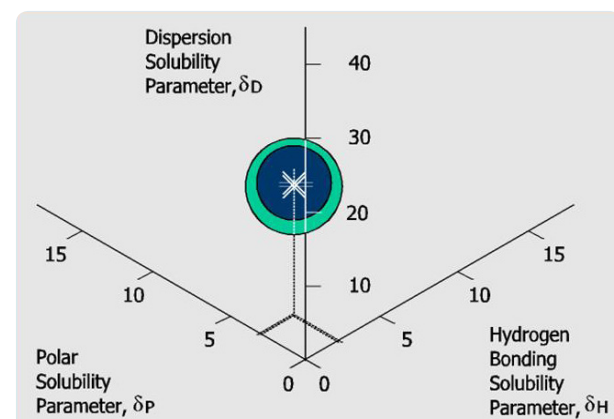


Diagram of Hansen's Solubility Parameters showing the relationship between solubility (blue) and environmental stress cracking (green) for a COC polymer

### Degradation and breakdown investigations

When damage occurs and a material is torn or otherwise degraded, FORCE Technology is available to find the cause. We can thereafter suggest ways of improving materials in order to avoid future accidents.

Our typical assignments in this area are:

- Torn plastic and elastomer – here the question often is whether the tears are caused by mechanical or chemical influence, and where in the material the tears originate
- Decomposed elastomer gaskets and plastic elements
- Failed adhesion in glued joints and plastic coating
- Surface purity and peeling paint
- Discolouration of plastic coating.



Environmental stress cracking in a PVC coupling

### Solubility parameters

Hansen's Solubility Parameters can be applied to choice of materials, product formulation and gauging the compatibility of materials, for example, pigments and binding agents on painted or glued surfaces.

FORCE Technology offers determination or calculation of Hansen's Solubility Parameters for polymer materials, solvents, colours and fillers, flavourings, gases, etc. We have at our disposal a database of around 1200 substances.

There are many advantages in knowing solubility parameters. This knowledge can be used, among other applications, to evaluate a material's chemical resistance, barrier capacity and miscibility with other materials, and to make environmentally friendly substitutions for more dangerous substances in a given process.

### Weather resistance and light-fastness

FORCE Technology has an array of possibilities for testing the weather resistance and light-fastness of materials and items.

The possibilities of exposure range from natural outdoor weathering resistance to laboratory-controlled artificial sun light in the form of filtered Xenon light (weather-Ometer) for both outdoor and indoor simulations, UV light, mist and humidity cabine.

Exposure can alter the characteristics of a material in many ways. FORCE Technology can measure changes in colour and gloss, corrosion, blistering, mechanical properties and adhesion.

Different modes of exposure are often combined in a cyclical test, for example, one that switches between salt-mist and light exposure to test paints' weathering resistance and corrosion-protective properties.



FORCE Technology's outdoor testing centre

### Advanced measuring techniques

FORCE Technology offers a number of advanced measuring techniques and tests. This affords great versatility and good documentary basis for testing materials. Below we mention a number of the measuring techniques we employ, along with examples of possible applications:

#### Moisture content and absorption

Can be used to evaluate plastics' and films' permeability from internal and external sources and their durability.

#### Surface tension

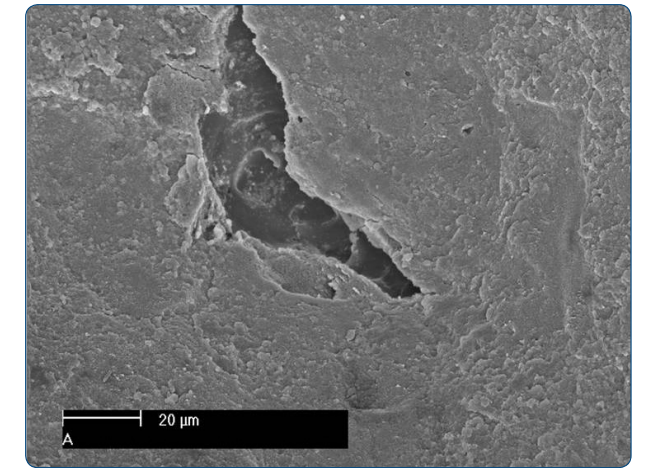
We offer accredited surface tension measurements of both liquids and solids. For liquids, it can be of interest to observe the wetting behaviour on a given surfaces. For solids, the measurements are often used to evaluate the surfaces' cleanness or adhesion properties.

#### Diffusion, permeation and migration

Examination of mass-transfer in and out of plastic materials. Isotopic measurements of diffusion, permeation and migration are used when the highest possible sensitivity is required in very low concentrations. Long-term diffusion can be estimated on the basis of a short-term test.

### Elemental analysis

Elemental analysis can be performed by diverse methods, including Environmental Scanning Electron Microscopy (ESEM) and it can be a vital part of a trouble-shooting analysis.



ESEM picture of a PVC pipe torn because of application of a non-compatible glue

### Environmental Stress Cracking (ESC)

More than 25% of all failures in plastic materials are presumably caused by environmental stress cracking. This is especially a problem in amorphous thermoplastics in contact with liquids, but also other types of plastic may be affected. For the great majority of products, suddenly occurring cracks can be catastrophic. We test whether a given plastic type might have problems with liquids or oils, or if there are other conditions that should be taken into account.

### Swelling of elastomer

Used to examine whether gaskets significantly change size with exposure to specific liquids or oils.



Measuring surface tension

### Compression set of elastomer

When elastomer is compressed for extended periods there can be physical or chemical changes that prevent it from returning to its original form. This may cause leaks in a system.