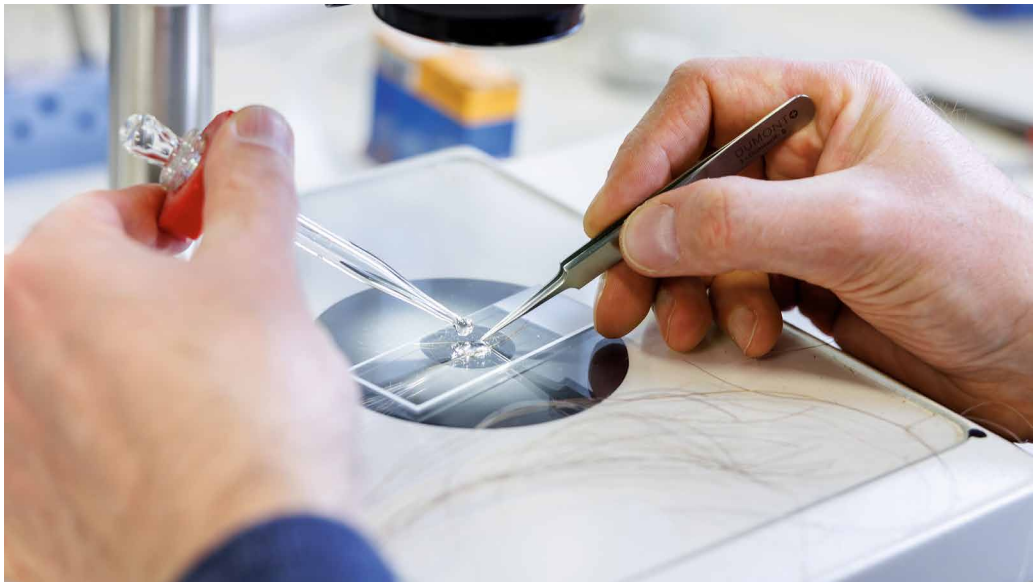
DITF LAB TOUR
TESTS & ANALYSES

GERMAN INSTITUTES OF TEXTILE AND FIBER RESEARCH DENKENDORF

DITF REPORT EXTRA

FROM MOLECULE TO PRODUCT

Textiles are more than just clothing. They play an important role in all future topics such as health, mobility, architecture, environment and energy. The requirements for the safety and functionality of these products are correspondingly high – and the demands on the quality of measurement and testing are increasing accordingly. Since their foundation more than 100 years ago, the DITF have had testing laboratories and offer a comprehensive service catalog of testing methods. In doing so, the DITF rely on well-trained specialists: Scientists, engineers, specialized laboratory technicians and technical assistants with many years of experience in testing textile precursors and textiles from a wide range of testing and quality assurance fields. This special edition of our DITF Report therefore not only shows you the services, but also the people who make this possible.



Fiber preparation under the microscope

FROM THE CONTENTS:

The DITF conduct research along the entire textile value chain – from the molecule to the product. The testing services are correspondingly diverse. The laboratories offer a wide range of standard test methods as well as numerous specialized areas. Analytical methods are used to analyze the textile- and clothing-related properties of polymers, fibers, yarns, twisted yarns as well as woven, knitted, laid and braided fabrics. The topic of health has a long tradition at the DITF, both in research and with numerous biological testing offerings. Environmental protection and resource conservation is another central research focus, the importance of which has also grown in testing services.

TAILOR-MADE TESTING SERVICES

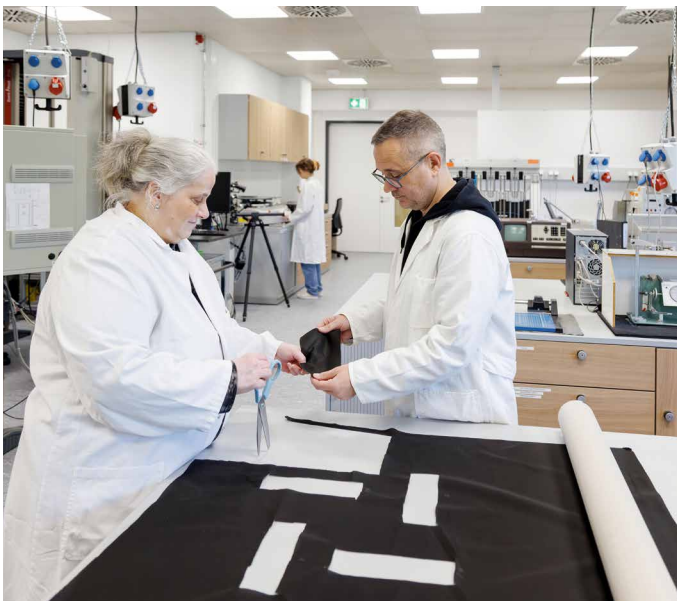
If a test cannot be performed using conventional methods, our specialists develop the appropriate procedures and build customized testing equipment. How much surface area can a disposable wipe impregnated with active ingredients clean and disinfect (area performance)? How do textiles in lightweight construction systems in bridges or vehicles behave in the event of a fire? Where are their mechanical load limits? Does protective equipment protect against cuts and punctures? These are just a few examples of a multitude of questions for which suitable testing methods have been found in the laboratories.

In addition to measuring and testing equipment, there are numerous setups that simulate textile processes and the effects of use. With their extensive experience in measuring, testing and simulating, the specialists in the laboratories and R&D departments support the industry and are active in teaching. They participate in German, European and worldwide technical committees such as standardization organizations.

FROM THE STONE AGE TO THE NEXT MOON MISSION

The fact that the skilled workers at the Service Center for Testing Technologies are very well trained was confirmed by a certificate as recently as 2022. The DITF received the award from the Chamber of Industry and Commerce for the training of the "outstanding examination participant Anne Reissmüller in the training profession of textile laboratory assistant".

The team of laboratory head Matthias Schweins can boast specialist knowledge and skills as well as extensive background knowledge. The colleagues work quickly, professionally and, above all, flexibly. Even though standard tests are the rule, the topics are always astounding. For example, more than 2500 textile fragments from pile-dwelling settlements at Lake Constance and Upper Swabia were the basis for a major project investigating prehistoric textile crafts. The textile archaeology department of the State Office for the Preservation of Monuments in Baden-Württemberg coordinated the research project under the direction of Dr. Johanna Banck-Burgess. The Service Center Testing Technologies was responsible for material testing using modern analytical methods. Result: Not only clothing, but also technical textiles were made from sometimes surprising materials.



Sampling in the laboratory

It was not into the past, but into the future that another project was headed. The European Space Agency (ESA) and its international partners launched a project to bring new momentum to space exploration: Returning to the Moon after more than 50 years. The missions back then showed that the so-called EVA equipment for "extravehicular activity" had major weaknesses. Space suits for long-term missions have to be adapted in this material-hostile environment. The consortium consisted of several partners who analyzed criteria for suitable materials. Much of the mechanical-technological testing was planned and performed at the Service Center Testing Technologies.

SENSE OF TOUCH AND CREATIVITY

The fact that the portfolio of the Service Center Testing Technologies extends from the past, through the present, and into the future is not just a play on words but a lived reality. But even the everyday jobs of the present, such as routine quality monitoring, supporting research and development, or testing damage cases for expert reports, never get boring. "In particular, damage analyses and expertises are my great passion" says Schweins. "Documenting defects, evaluating facts and determining causes – this often requires a sense of intuition and creativity." The challenge is that there are no standard tools and procedures for damage assessment. Methods are decided depending on the defect pattern, and standard or simulation tests are defined based on experience. The Service Center Testing Technologies cooperates here with industry and external experts. Not only classical textile expertises are processed, but also expertises from the field of medicine and especially from the field of automotive.

Over the years, fencing has proven to be the specialty of the Denkendorf testing experts. The protective clothing for fencers is intended to prevent injuries or, in the worst case, to keep the degree of injury as low as possible, especially from the point of the weapon. The protective clothing listed in DIN EN13567 includes two levels of protection. Their use is expected to reduce the risk of injury to fencers to a tolerable level. These tests are carried out in the Service Center Testing Technologies for renowned fencing clothing manufacturers.

Determination of maximum tensile force and maximum tensile force-elongation on a seat belt

The Service Center Testing Technologies is accredited according to DIN EN ISO/IEC 17025:2018. Thanks to state-of-the-art technology, versatile laboratory equipment and individually tailored testing processes, both standardized and specialized tests can be carried out. Entirely according to the needs of the customers.

All testing services and service specifications can be found at www.ditf.de/testing-laboratories. Further tests on request

DETECTIVE WORK WITH MYSTERIOUS DOTS

What do barely visible blue dots on light-colored or white car seat belts and bras have in common? "The phenomenon appeared increasingly as a complaint in the testing laboratory about 20 years ago," reports Dr. Frank Gähr, head of the Chemical Testing Laboratory at the DITF. Finding the cause turned out to be detective work, especially since the spots occurred only sporadically. For a long time, the researchers were in the dark until chance came to the rescue Gähr recalls. When a blue dot was examined under the microscope on a beige belt, the charred remnant of a cotton fiber was found. Obviously, it was a fiber that came from a ripped wool widely used in factory halls for cleaning. It also contains vat-dyed blue tree fibers (from blue work clothing).

Chromatographs separate substances into their components. In this way, the compositions of mixtures or the molecular weight distribution of polymers can be investigated.

These are deposited as fiber fly on the textiles, are burned in during hot treatments such as the thermosol or molding process, and lead to the notorious blue spots. In addition to the successful completion of the test order, the discovery also had an aftermath on the research side: Apparently, vat dyes can be used to dye not only cotton but also synthetic fibers. This led to two patent applications for the dyeing of polypropylene and aramids with vat dyes, the dyes being characterized by very high lightfastness.

Another time, the company had to use its ingenuity to find out why wiping mops that appeared to be unchanged during production suddenly tore all the time when used in hospitals. In fact, optical brightening agents had been added to the fibers, which did not withstand the high temperatures during washing.

DIFFERENT MATERIALS – DIFFERENT METHODS

These are just two examples of the fact that orders in the textile chemistry/chemical fibers testing laboratory can rarely be completed with routine. The materials to be tested are far too diverse for that. The palette ranges from superfine spider silk to PVC-coated fire hose made of Cordura, from sofa cover fabric made of bamboo viscose fiber, the examination of multilayer laminates to artificial hip joints made of CFRP.

The range of methods is wide. Spectroscopic investigations provide information about the nature of fiber materials, coatings and surfaces. IR spectroscopy can be used, for example, to detect whether fluorochemicals, kerosenes or silicones have been used for a water-repellent finish. This method can also be used to distinguish whether a textile has been finished with fluorocarbons or with PTFE. Contact angle and tensiometer measurements can be used to quantitatively determine the surface tensions that are important for adhesion properties. Chromatographic analysis such as GC, HPLC or GPC can be used to obtain information on the material composition of unknown substances or on the molecular weight distribution of fiber polymers. Thermoanalytical methods such as DSC or STA are often used to characterize fiber polymers based on their melting and crystallization behavior.

The development of analytical methods for special, day-to-day issues is an important part of the work in the testing laboratory. These are increasingly in focus, especially under the aspect of sustainable product design. This includes, for example, the development of a rapid test to distinguish between spun-dyed and subsequently dyed fiber material, or the installation of an analytical method to distinguish between virgin and recycled fibers.

Automated, potentiometric titration is used to determine end groups and thus, for example, the molecular weights of polymers.

COATING AND FINISHING ON A LABORATORY SCALE

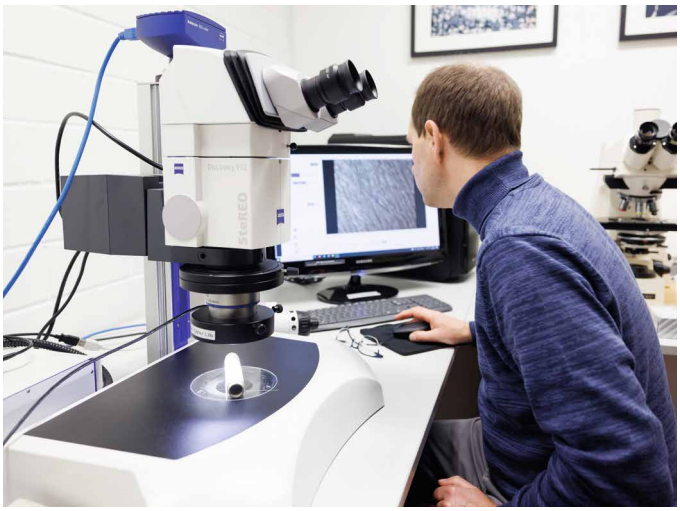
In the new Chemical-Technical Laboratory, textiles are finished, coated and heat-set on a laboratory scale for a wide range of functions. The current focus is on fluorine-free water and oil repellency, environmentally compatible, catalytically active antibacterial finishes and biodegradable protective coatings for geotextiles made from natural fiber materials.
For formulation development, measuring equipment for rheology, residual aviva content, surface tension and a modern digital microscope are available. Special testing equipment such as for oil/water separation, the rise height in water-transporting capillary textiles, and open and closed flow channels have been built for research work. In cooperation with the DITF's Service Center Testing Technology, the team has been determining the cut resistance of ski underwear against a real freshly sharpened ski steel edge worldwide for two years. "This particular underwear can prevent the life-threatening severing of blood vessels in the arms and legs" explains Dr.-Ing. Thomas Stegmaier, head of the Competence Center Textile Chemistry, Environment & Energy. This demanding test was developed with the Fédération Internationale de Ski (FIS) and is the basis of the FIS 5-star award for these protective textiles used by ski athletes.

Testing of a newly developed oil/water filter material in an industrial filtration plant

The laboratory of the DITF subsidiary ITV Denkendorf Produktservice GmbH (ITVP) complements the range of tests for the characterization of polymers and chemicals.

THE VIEW INTO THE SMALLEST DETAILS: FIBER-/TEXTILE MICROSCOPY AND X-RAY STRUCTURE ANALYSIS

The structural properties of fibers, composites and textiles can also be analyzed at the DITF using various scientific light microscopes, a confocal Raman microscope and a high-resolution field emission scanning electron microscope. New materials are studied from the macroscopic to the micrometer scale, for example to determine the crystalline structure of ceramic fibers. "What is important here is the exact microscopic preparation tailored to fibers. Without this preparation, there are no meaningful and perfect microscope images" emphasizes Ulrich Hageroth from the Central Microscopy team. Various methods are used in Denkendorf, for example, the samples are embedded in different resins, they are dyed or ground.
X-ray structure analysis enables the determination of crystallinity and thus a deep insight into the three-dimensional structures of the molecules and their complexes. A wide-angle and a small-angle X-ray diffractometer are available at the DITF for the analysis.



Analysis of yarns and textiles on the stereomicroscope

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SAFETY FOR THE SKIN

There are many test labels for textiles. The test label of the Fördergemeinschaft Körperverträgliche Textilien (FKT) is different and offers more. Over 20 years ago, a procedure was developed at the DITF that not only tests for individual known harmful substances, but also checks how the entire textile with all its components affects the skin.

In the tests, the skin is simulated by a gel on which the textile sample is placed. To ensure that the test is realistic, a substance is added that imitates human sweat. If there are chemical substances in the textile that dissolve out when worn, they are transferred to the gel. The scientists then extract a so-called eluate from the gel and bring it together with viable skin cells. "If the eluate contains cytotoxic substances, the cells are prevented from proliferation or are damaged," explains Dr.-Ing. Andreas Scherrieble, deputy head of the Biological Testing Laboratory.

Cell biological testing at a clean bench

SAFE MEDICAL DEVICES AND PROTECTION AGAINST MICROORGANISMS AND PARTICLES

Medical textiles rightly have to meet high requirements. These include not only textile implants, wound dressings or surgical drapes and gowns. "Few people know that wheelchair covers, compression textiles or bras after mastectomy also belong to Class I medical devices" explains Evi Held-Föhn, head of the Biological Testing Laboratory. Testing for a toxic effect of the textiles on cells is therefore essential. Like most of the biological test methods in the Biological Testing Laboratory, these so-called cytotoxicity tests are also accredited according to DIN EN ISO/IEC 17025.

For many years, a laboratory of biosafety level 2 has been available for activities with microorganisms. Here, tests are carried out in particular for antibacterial properties of textiles with bacteria, which play a significant role in the so-called hospital-acquired infections. In addition to the wide range of antibacterial tests, the DITF would like to expand its range to include antiviral tests. Working with viruses that can cause disease in humans or animals requires overcoming additional high regulatory obstacles. "We are confident that with this approval we will soon be able to test the extended requirements for textiles that have resulted not least from the COVID 19 pandemic," says Held-Föhn.

Determination of the bacterial penetration with the ReBa² test device

In Denkendorf, a new biological method will supplement the range of tests for cleanroom garments in the future: the **Re**alistic **Ba**cterial **Ba**rrier (ReBa²) test method. Particularly in the production of sterile pharmaceuticals in cleanrooms, bacteria, skin flakes and fiber particles that originate from persons and their clothing pose a risk. Special cleanroom garments have the task of minimizing this risk. For this purpose, among other tests the bacterial penetration through the textile is determined and evaluated: How many bacteria of the human skin microflora can migrate through the textile to the outside? With the new ReBa² test method, it is possible to make a meaningful determination of the bacterial penetration under conditions close to reality. The intensity of the mechanical stress and the stress period can be variably set during the test procedure. Additionally the influence of intermediate clothing worn under the cleanroom garments is taken into account.

The biology lab tests whether or how many bacteria find their way through the protective clothing. In the test laboratory for cleanroom textiles, tests are carried out to determine how many airborne test particles are held back by cleanroom clothing or surgical textiles. "This allows us to assess a potential danger for the products in the cleanroom" explains Gabriele Schmeer-Lioe, who leads this lab. In the ISO 4 test cleanroom at the DITF, she also tests whether and how many particles the textiles used in the cleanroom release into the environment. Among the methods used are the Suction/Counter method and the Helmke-Drum test. The DITF are the only research facility in Germany that offer these tests.

Sensitive products such as electronic components, pharmaceuticals or food products are manufactured in cleanrooms. Cleanroom garments and wiping textiles must therefore not release any particles into the cleanroom.

Determination of the particle emission of cleanroom garments using the Suction/Counter method

PROTECTION AGAINST SPARKS

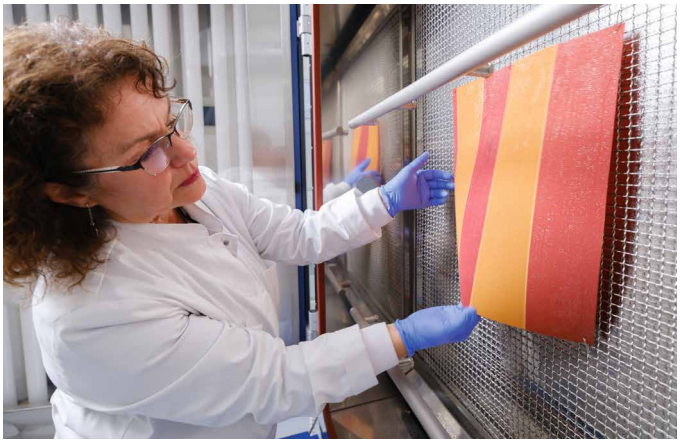
To ensure that sparking does not lead to explosions, the electrostatic behavior of textiles is of great importance, especially for protective clothing, but also for various technical applications. In the electronics industry, even the smallest spark discharges caused by charged textiles can destroy sensitive components. The danger potential can be determined in advance. For this purpose, the electrical resistance and the friction-induced charge, among other things, are measured in the laboratory. These tests are also part of the area of responsibility of Gabriele Schmeer-Lioe. The experienced engineer has been at the DITF for more than 40 years and has seen how quality assurance and safety became increasingly important. "We also have to be creative sometimes. There are products for which there are no relevant textile standards for testing. These are for example filter tubes, ropes and conveyor belts. Here we find special solutions," reports Schmeer-Lioe.

Determination the point-to-point resistance of cleanroom garments for the ESD sector

AGING DUE TO ENVIRONMENTAL INFLUENCES

Fibers, yarns and textile fabrics are exposed to many different environmental influences that can affect their quality and functionality. The DITF have many years of experience in simulating these influences in time-lapse in the laboratory. UV light or strong artificial light as xenon lamps not only cause colors to fade, but can also make the material brittle. But the sun does not shine the same everywhere. In Florida, the environmental influences are different from those in Norway. That's why different climatic zones are simulated in the lab – a special feature of the Denkendorf labs. Other factors such as temperature, humidity, rain, dew and ice can also be adjusted, completely individually according to customer requirements. Time-accelerated aging tests provide customers with fast results.

Visual evaluation of fabric samples during color fastness testing against artificial light



Removal of the awning fabric sample weathered with rain, among other things, for further testing

TEXTILES UNDER THE EARTH

Three functions are involved: Reinforcing, separating, filtering. Whether it's a highway or a parking lot – a reliably stable subgrade is indispensable in road construction. Among other things, geotextiles perform this task. Depending on the area of application, they have to be durable for different lengths of time. The textile used to stabilize slopes until the newly planted plants have developed their roots may well rot quickly. In contrast, a textile used in road construction must hold up for several years. How quickly the textile fabrics decompose is tested at the DITF – both in the open in certified humus and in the climate chamber according to DIN standards.

Since 2020, Cigdem Kaya has headed the Barrier Textiles team, which, in addition to working on research projects, is responsible for the special laboratories for environmental simulation, cleanroom textiles as well as electrostatic behavior. The environmental simulation lab includes an aerospace engineer scientist and a lab technician with chemical engineering training. Kaya herself holds a degree in Textile Engineering, from Istanbul Technical University. When she came to Germany in 2005, she supplemented her studies at Sigmaringen University with a master's degree in Textile and Clothing Management. "I didn't speak a single word of German at that time" she recalls and laughs. That changed very quickly. In 2010, she had already written her master's thesis at the DITF – and stayed. First as a research assistant, then as a team leader.

BACK INTO THE CYCLE: BIODEGRADING TEXTILES

Sometimes rotting is also desired. To protect the environment, it is important that materials and products biodegrade. How long this takes and whether it is completely successful is tested in Denkendorf in the L2 environmental laboratory with the help of microorganisms such as bacteria and fungi under various environmental conditions. Standards are in place to assess degradability. "The need for testing is great" emphasizes Dr.-Ing. Jamal Sarsour, team leader of the Environmental Technology Research Group at the DITF. "And that need will continue to grow." As yet, he says, the production of biodegradable textiles is voluntary and, above all, good for the image. "At some point, it will be mandatory to comply with the standards" Sarsour is convinced.

The respirometer examines how a sample degrades. It measures the exchange rate of oxygen and carbon dioxide – in other words, how much is "respired" by the microorganisms. The more they "breathe", the more is biodegraded.

In recent years, various test methods have been set up at DITF to biodegrade textiles under both aerobic conditions (microorganisms that require oxygen) and anaerobic conditions (microorganisms that produce methane in the absence of oxygen). They are carried out in water and soil under controlled conditions in the laboratory and under real conditions in the field. In the process, the research center cooperates with the operators of wastewater treatment plants, biogas plants and composting plants.

ACCELERATE DEGRADABILITY

Basically, many garments are biodegradable, but unfortunately not fast enough to meet the standards for industrial composting. This is also true for an ordinary cotton t-shirt. Although the shirts are made of natural fibers, many would not receive the seal of approval – depending on how the fiber was pretreated and processed. Current international biodegradability standards tend to focus on materials that biodegrade relatively quickly. But the process can be accelerated. The Denkendorf researchers are planning a research project on this. "The goal is faster degradation by a factor of 4" explains Dr.-Ing. Thomas Stegmaier, head of the Competence Center Textile Chemistry, Environment & Energy. "This means that with new processes, biodegradation can be achieved in 45 days, which previously took 180 days." The new test method should enable simple certification of slow-biodegradable textile materials. "The DITF want to award a separate seal for this. The draft is already ready and waiting for use" adds Sarsour.

The ARBOBLEND® variant from the company TECNARO shown in the picture is degraded in the routine operation of a biowaste composting plant. (From left to right) before composting, after 2 weeks, after 6 weeks, after 12 weeks.

QUALITY MANAGEMENT AT THE DITF

DITF's customers and partners can expect the highest quality in testing services. This standard is lived by the employees and secured by a comprehensive quality management.

Accreditations
A part of the laboratories is accredited with numerous test methods according to DIN EN ISO/IEC 17025:2018 by DAkkS (Deutsche Akkreditierungsstelle GmbH).
The accreditation certificates and a current list of all accredited test methods (range of services) are available for download at www.ditf.de/qualitaetsmanagement.

The DITF are members of EUROLAB – Germany, the national section of EUROLAB European Federation of National Associations of Measurement, Testing and Analytical Laboratories.

All testing services and service specifications can be found at www.ditf.de/testing-laboratories. Further tests on request.

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