Prof. Frank Walther of TU Dortmund University

We interviewed Professor Dr. Frank Walther, Head of Department of Materials Test Engineering (WPT) at TU Dortmund University in Germany. His research is focused on microstructure-based materials and components testing, destructive and non-destructive testing and measurement techniques as applied to characterize structure-property relationships, evaluating the fatigue performance, failure mechanisms and damage processes and predicting remaining fatigue life. He and Shimadzu started collaborative research with first contact in October, 2011. A number of discoveries and achievements have been made with Shimadzu testing machines and analytical instruments such as Autograph (AGS-X, AG-X) and Servopulser (EHF) systems, micro magnetic (MMT) and ultrasonic fatigue testing (USF) systems, ultra-micro hardness tester (DUH), and so on.

Shimadzu:

Professor Walther, thank you very much for spending some time for this interview. Firstly, could you tell us the background of this collaborative research? Why did you choose Shimadzu as your partner?

Prof. Walther:

My research group investigates basic- and application-oriented topics in the field of destructive and non-destructive materials and components testing. Microstructural and mechanism-based characterization of the Low-Cycle-Fatigue- (LCF-) to Very-High-Cycle-Fatigue- (VHCF-) behavior is the key subject. Main modules of the research strategy are the analysis of materials and microstructures, the application of process- and product-optimized measurement techniques for characterization as well as modeling of properties and calculation of lifetime. The exact assessment of the influence of production and in-service conditions on basic material parameters leads to optimized property profiles and enhanced functional safety of components. The portfolio of research ranges from scientific fundamental research to applied (bilateral) development and analysis services for industrial companies.

When I established the Department of Materials Test Engineering (WPT) in December, 2010 at TU Dortmund University, I had nearly no laboratory equipment. Within the context of lab expansion and network building, I contacted the Product Manager for Material Testing Systems at Shimadzu Duisburg, Germany. This was the first contact with Shimadzu, which I did not know before. On the basis of a good understanding and successful implementation of initial projects, a successful collaboration was initiated.

During the installation of initiatory Shimadzu materials testing systems in WPT lab, the quality of the devices and the well-trained service engineers attracted my attention. In addition to these profound impressions, the distance between Duisburg and Dortmund is only 50 km, so that mutual visits in Shimadzu or WPT lab are possible with very less effort.

Shimadzu:

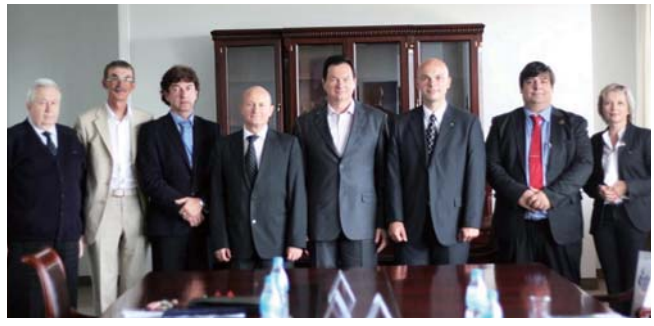
Then could you outline the research and let us know which discoveries and achievements have been made so far?

Prof. Walther:

First of all, development of a well-organized WPT laboratory infrastructure was realized. On the basis of my 15+ years' experience in Materials Testing, I started to evaluate Shimadzu devices and was convinced of hardware and software quality and capability. All these initiatives were appreciated and supported by Shimadzu Europa GmbH.

Picture 1: Prof. Walther at Shimadzu Headquarter Kyoto, Japan

In the context of increasing collaboration for the exchange of experiences, a meeting was organized at Shimadzu's headquarter in Kyoto, Japan (Picture 1). There, substantial fruitful discussions took place and many promising further hardware and software developments were comprehended. Within the initiative to build up a Shimadzu network with reference customers, an additional visit at FEFU University in Vladivostok, Russia, took place (Picture 2). With the support of the Rector of FEFU University, it was decided by the colleagues Prof. Gridasov and Prof. Pogodaev, to work closely together e.g. in DFG (German research foundation) research projects.



Picture 2: Prof. Pogodaev (left), Prof. Gridasov (second from the left), Prof. Walther (third from the right) at FEFU University, Vladivostok, Russia

During my visit to Russia, there was also a Shimadzu fair taking place where I presented my results obtained in industrial research projects carried out using Shimadzu systems (Picture 3).

From the current year, I'm acting as a Visiting Professor at FEFU University. Besides the presentation of a fatigue course, an exchange of PhD students was agreed upon. The first PhD candidate from FEFU visited WPT in December, 2013 for experimental investigations concerning the fatigue performance of glass-metal composites.

In the meantime I visited many colleagues working together with Shimadzu in Germany and Europe. In January, 2014, I was invited for a Shimadzu International Sales Meeting to illustrate the basics of fatigue and lifetime prediction to sales representatives.

As I know from many projects, fatigue assessment is much more than collecting conventional Woehler lines, as especially industrial companies look for new time- and cost-effective testing approaches. WPT has patented the so-called "Rapid Fatigue Performance Identification Method (RAPID)" which works successfully for all investigated metals as well as polymer- and wood-based composites. The idea of RAPID is to estimate fatigue characteristics in short time for process-oriented manufacturing. RAPID allows to calculate the Woehler line on the basis of one multiple step test and two single step tests. The basics are presented in Walther, 2014, see below.

Picture 3: Prof. Walther (fifth from the right), Prof. Pogodaev (fourth from the right) and Shimadzu staff at Shimadzu fair, Vladivostok, Russia

Shimadzu:

Why are you interested in this research? What is the goal?

Prof. Walther:

Mechanical properties are combined with microstructure or microstructural changes due to production process and in-service loading. In this sense, microstructure could be understood as a fingerprint of the component properties and new non-destructive measuring techniques allow to describe the relation between microstructure and properties.

During my PhD, I worked on the fatigue assessment of ICE train wheels, as there was the Eschede (Germany) accident in 1998. My research topics are: quenched and tempered high strength steels for highly loaded parts, stainless steels for chemical plants, cast irons, lightweight metals as aluminium, magnesium and titanium, and recently carbon-fiber reinforced polymers (CFRP) and wood-based composites like vulcanized fiber. Additionally, joining techniques like friction-stir welding, brazing and bonding are investigated.

The goal is to understand the fatigue performance and failure mechanisms with the help of new measurement techniques on the basis of a small number of tests, to support industry in optimizing their process chain parameters regarding optimized component properties. The desired local component property should be reached on the basis of a well-understood structure-property relationship. Besides, the determination of the influence of corrosion on the fatigue properties and corrosion fatigue properties as well as corrosion prevention procedures are a further central research topic at WPT.

Shimadzu:

How are our instruments helping you?

Prof. Walther:

The instruments and the installed, Shimadzu as well as self-developed, softwares build the fundamental basis for experimental investigations (Picture 4). From WPT staff and many student workers, I know that especially the autograph software is very customized and self-explanatory. Excellent hardware and software quality are important criteria for the successful use of instruments to reach precise results in research and industry projects with minimum efforts.

Shimadzu:

What are Shimadzu's strengths compared to other competitor companies (not limited to the instruments) ?

Prof. Walther:

One of the Shimadzu strengths is to have a complete range of testing systems required for optimized investigations in research and industry. Besides the quality and capability of testing devices, I appreciate the close relationship to Shimadzu Europa headquarter. The European testing material team understands the demands of research institutes and supports us in a proper way. So we quickly learned that Shimadzu is treating their customers not only as a client, but as real partners. I am also deeply impressed about the high professional skills of the support team and the service engineers. The network serves as an ideal platform for information exchange and user discussions, also in the sense of new developments together with customers. Being comprehensive and communicative to its customers is the core competitive asset of Shimadzu.

Shimadzu:

Finally, could you share any requests that you have with respect to analytical and measuring instrument vendors?

Prof. Walther:

Actually, everybody in the fatigue community speaks about Very High Cycle Fatigue. In this year there is the 6th International Conference on Very High Cycle Fatigue (VHCF6) in Chengdu, China. I was very surprised when I heard that Shimadzu has a USF-2000 device in its portfolio. I am sure that this is not well-known in Germany, so marketing efforts and representation at prestigious conferences should be increased.

In case of lightweight alloys, the crash behavior is mandatory for industrial applications. Due to CE reasons, the HITS system, which I used in Kyoto for tests up to 20 m/s with a force up to 10 kN is unfortunately not available in German market.

I would recommend Shimadzu to proceed in the same way regarding quality of products and qualification of engineers, but to transfer more systems from Japan to Germany and increase marketing, especially for instruments needed in current research topics, and

conference attendances.

I am very happy that Shimadzu attends and supports, as Premium sponsor, the 1. Dortmunder Werkstoff-Forum from September 30 until October 1, 2014, in Dortmund, Germany, organized by myself.

Shimadzu:

It was significant to know what you think of us and our collaboration. We will strive to meet your expectations more than ever. Thank you very much.

Picture 4: Impressions from WPT labs, TU Dortmund University, Germany

Here are his recent publications:

- Wycisk, E.; Emmelmann, C.; Siddique, S.; Walther, F.: High Cycle Fatigue (HCF) performance of Ti-6Al-4V alloy processed by Selective Laser Melting. Advanced Materials Research 816-817 (2013) 134-139.
- Klein, M.; Wittke, P.; Dieringa, H.; Walther, F.: Influence of corrosion on fatigue properties of new creep-resistant magnesium alloy DieMag422. LCF 7, 7th Int. Conf. on Low Cycle Fatigue, Proc., ISBN 978-3-9814516-2-7 (2013) 319-324.
- Dieringa, H.; Huanga, Y.; Wittke, P.; Klein, M.; Walther, F.; Dikovits, M.; Poletti, C.: Compression-creep response of magnesium alloy DieMag422 containing barium compared with the commercial creep-resistant alloys AE42 and MRI230D. Materials Science and Engineering A 585 (2013) 430-438.
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- Manka, M.; Wojarski, L.; Tillmann, W.; Frieling, G.; Myslicki, S.; Walther, F.: Fatigue behavior of brazed AISI 304 joints using Au-fillers. Loet 2013, 10th Int. Conf. on Brazing, High Temperature Brazing and Diffusion Bonding, Aachen, DVS-Berichte Band 293, ISBN 978-3-87155-611-1 (2013) 232-236.
- Holweger, W.; Walther, F.; Loos, J.; Wolf, M.; Schreiber, J.; Dreher, W.; Kern, N.: Non-destructive subsurface damage monitoring in bearings failure mode using fractal dimension analysis. Industrial Lubrication and Tribology 64, 3 (2012), 132-137.
- Starke, P.; Walther, F.; Eifler, D.: "PHYBAL": a short-time procedure for a reliable fatigue-life calculation. Advanced Engineering Materials 12, 4 (2010) 276-282.
- Walther, F.: Microstructure-oriented fatigue assessment of construction materials and joints using short-time load increase procedure. MP Materials Testing 56, 7-8 (2014) 519-527.
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