Publication for the Peening, Blasting, Cleaning and Vibratory Finishing Industries

Separate Print

Vol. 22, July Issue, Year 2021

Interview With Yoshiyuki Aono, Director, PULSTEC Industrial Co., Ltd.

Fast And Simple Set-up X-ray Residual Stress Measurement Based On Cos-alpha Method

PULSTEC

Create New Value

Pulstec Industrial Co.,Ltd.
7000-35 Nakagawa
Hosoe-cho, Kita-ku, Hamamatsu-city
Shizuoka Pref., 4311304, Japan
Tel. +81.53.522-3611
E-mail: y-teramoto@pulstec.co.jp
www.pulstec.co.jp/en/

Fast And Simple Set-up X-ray Residual Stress Measurement Based On Cos-alpha Method

Introducing the truly portable rapid non-destructive X-ray-based residual stress analyzer from the technology development company PULSTEC, in accordance with its philosophy to "Create New Value".

Using the innovative cos-alpha method for stress analysis, PULSTEC Industrial Co., Ltd. Japan has developed a fast, reliable and highly portable X-ray diffractometer.

MFN interviewed Sales Director Yoshiyuki Aono and the Global Sales Manager Yoshinobu Teramoto of PULSTEC Industrial Co., Ltd. Japan.

Yoshiyuki Aono, Director, PULSTEC Industrial Co., Ltd.

(?) MFN: First please introduce your company PULSTEC.

(!) Y. A.: PULSTEC Industrial Co., Ltd. was founded in 1969, 52 years ago. The company is located in Hamamatsu city, almost at the center of Japan's main island, situated between Tokyo and Osaka. Hamamatsu is an industrial city, with a population of about 800.000, and is the long-term home of many well-known companies from the automotive and musical instrument sectors including YAMAHA, HONDA, and SUZUKI. PULSTEC initially gained a reputation as a developer and supplier of many different measurement instruments and systems to these industries, often developing customized products to meet our customer's specifications. Based on these past experiences, PULSTEC's engineers developed considerable experience in electronics, mechanics, software technologies and particularly in measurement instrumentation for the analysis of very small electrical signals and optical technologies. After the startup period, PULSTEC successfully expanded its business sector by launching original products to a world-wide high-tech market and became listed on Tokyo's Stock Market. Our business has continued to diversify into many different fields such as the steel industry, optical measurements and healthcare instrumentation, to name just a few. Important to us over these past 52 years has been developing good relationships with our customers, not only in Japan, but also world-wide.

(?) MFN: When did the relationship with MFN begin?

(!) Y. A.: The first MFN event at which PULSTEC was represented was the Shot peening Workshop & Trade Show, held in 2016 in Singapore. We participated in this event as exhibitors. After that, we met MFN again at the international conference INCASE 2019. We especially appreciate the large number of interested participants at the MFN events.

(?) MFN: Please introduce PULSTEC's portable X-ray based residual stress analyzer to us.

(!) Y. A.: In the past, residual stress measurements were complex to set up, very time-consuming, and could often only be used in laboratories by appropriately trained personnel due to the design and dosage rate of the measuring instruments used. With our portable residual stress analyzer, residual stress measurements can be carried out more quickly and easily due to the low radiation exposure, uncomplicated set-up and operation.

This leap in analysis technology was possible because the instrument is equipped with a unique large area 2-dimensional X-ray detector, which along with its X-ray tube, is contained in a single small portable unit. Additionally, the fully automatic cos-alpha method of measurement data analysis requires minimum interaction by the operator. The cos-alpha analysis method was developed by a Japanese professor in 1978. This measurement method uses the complete "Debye-Scherrer ring" (D-S ring) data, captured by a 2-dimensional detector following a single

PULSTEC Headquarters

Yoshiyuki Aono (right) and Yoshinobu Teramoto (left), Global sales manager

short duration X-ray exposure. In the early days of developing the cos-alpha method, X-ray film had to be used, then after developing the exposed film, the resulting D-S ring image was measured and all calculations were made manually to determine the residual stress.

Recently, PULSTEC collaborated with the professor, and we were able to greatly improve the detection and analysis of the diffracted X-rays. Applying PULSTEC's technology, a single short duration X-ray exposure of the sample, followed by X-ray detection, analysis and then immediately re-setting the detector could all be achieved within a few minutes, and is completely automatic. This is made possible by utilizing an image plate (IP) instead of X-ray-sensitive film in our portable stress analyzer, which is reusable and can be read out automatically.

We have already experienced many successful applications for the measurement of residual stresses using the cos-alpha method in advanced R&D engineering fields, especially for machine manufacturing and engineering structures.

It was back in 2012 that we released our first version of this X-ray residual stress analyzer. In the beginning, some people were doubtful that the system would be comparable to the existing XRD-method, and typical comments included "*is it possible to measure the residual stress using such a small & simple instrument?*" The quality of the measurement was to be independently confirmed, as in 2020, when the cos-alpha method became a standard in Japanese academic society, being approved by The Society of Materials Science. They validated the correlation with the existing XRD based method following extensive round-robin testing by their standardization working group. Also, they confirmed the practical nature and accuracy of analyzing the D-S ring using a 2-dimensional detector, with a single low-powered short-duration X-ray irradiation pulse. It was concluded that this technique is likely to be widely used in the future and hence needed consideration for standardization.

Thank you for the opportunity to introduce this technique! I hope the information presented will be useful for many researchers and engineers.

(?) MFN: How is the business going?

(!) Y. T.: So far, we have met many engineers & researchers at various academic meetings and exhibitions around the world, and their feedback has confirmed the importance of measuring residual stresses in engineering components and structures. We have identified various kinds of applications, which are well suited to the small size and light weight resulting in the mobility and portability of the system; these for example, include onsite applications as well as integration with robotic systems. PULSTEC's engineers now have substantial experience and frequently work with customers to propose various solutions to meet customer's requests.

Currently, PULSTEC has installed over 400 of our portable X-ray residual stress analyzers in 17 countries; it might be as many as 450 systems by the time this article is published.

Our sales base is in Hamamatsu city, with branches in Tokyo Japan, and California in the USA. As PULSTEC see its customer base to be worldwide we found it is necessary to form partnerships with a number of agent companies. For example, in Europe, one of our partners is the innovative German company "Sentenso", which has considerable experience in surface-enhancement engineering.

Our system is also used by many universities and research laboratories at numerous locations including, Japan, USA, U.K., Germany, China and Singapore as well as by various major automotive manufacturers and many other engineering manufacturing companies. I would like to introduce our system to more people worldwide, and hope it will be helpful for those in R&D as well as production, particularly for different kinds of industries including automotive, machinery, aerospace, etc.

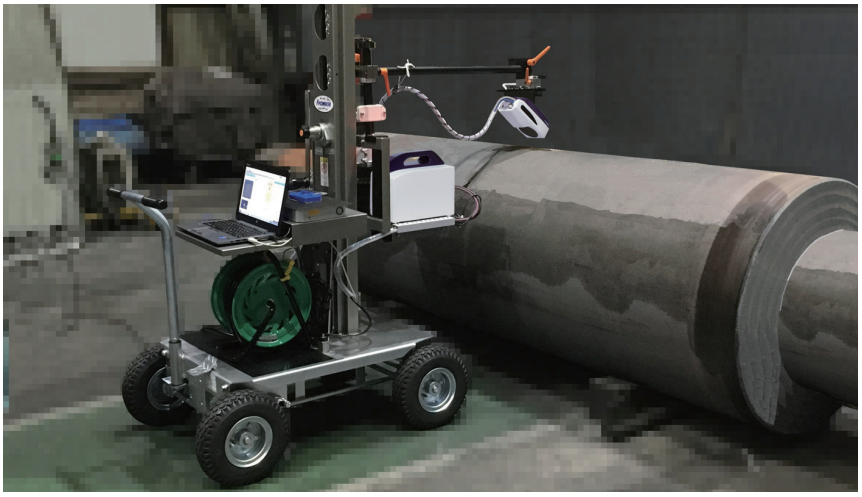
« Recently we have applied our X-ray diffraction technology in a new approach, as a "Non-contact Surface Hardness Variation Scanner" called "muraR". »

Yoshinobu Teramoto, Global sales manager of PULSTEC Industrial Co., Ltd.

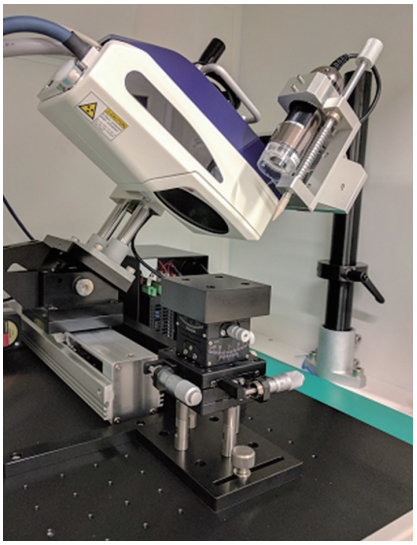
We believe it would be useful to aid the development of new technologies, high quality and safety products.

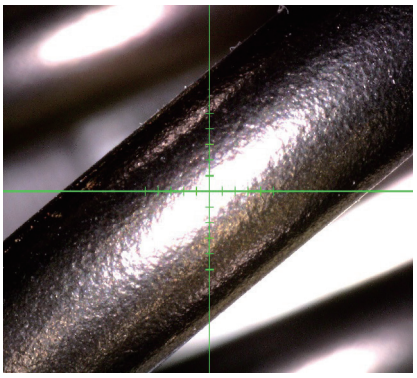
(?) MFN: What about future plans?

(!) Y. T.: We have developed not only the main instrument but the various measurement support tools and safety facilities such as shielding cabinets as well, all as optional items. PULSTEC endeavours to maintain good communications with our customers, listening to their requirements and providing them with solutions. From our experience, the portability of our residual stress measurement system has solved many onsite measurement problems. PULSTEC has developed various associated tools to aid this type of measurement. Sometimes components have difficult shapes, and some customers need to measure large objects, whilst others need to measure small components, some of which have narrow spacings, etc. Many of these types of measurements have proved exceedingly difficult for other XRD systems to obtain reliable data.



On-site measurement





Microscope tool

Additional items we supply include various collimator apertures and tools to change the X-ray beam spot size, and we also supply a range of different X-ray sources. To take advantage of the rapid measurement speed, we have an automatic mapping option that enables area stress mapping. There is also a microscope tool option for accurately positioning the smallest diameter beam spot. Another customer needed to make numerous measurements on a large component, and our engineers designed and built a cart to support the X-ray analyzer.

We have extensive experience in the analysis of stresses due to metal surface-finishing treatments. Measuring residual stresses by XRD is particularly suitable as it is a surface/sub-surface technique; however, there is occasionally a need to determine how stress varies with depth below a components surface. Consequently, PULSTEC provides its own electro-polisher, enabling localized controlled electro-chemical removal of metal, by combining an alternating polish then measure, in a repeated strategy, to produce a depth profile of the residual stress distribution as a function of depth.

One new developing technology is that of additive manufacturing that often requires residual stress measurement in 3D printing. I think as more manufacturers use this production method, residual stress measurement in the form of a surface stress distribution map will become a more important parameter across many industries.

Recently we have applied our X-ray diffraction technology in a new approach, as a "Non-contact Surface Hardness Variation Scanner" called "muraR". It's not a single X-ray spot measurement, but the X-ray beam is scanned over the object's surface. It has been used, for example, to detect errors or variations resulting from a heat-treatment process that increased distortion in the crystal structure, and these changes correlate with hardness measurements; similarly for more localized structure variations, for example, following machine burning, etc., as these changes give a localized change in the hardness. Given the size and short analysis time, we foresee it being used in production processing as part of the quality control in steel products manufacturing.

PULSTEC continues to provide solutions for customer's problems.

MFN would like to thank Yoshiyuki Aono and Yoshinobu Teramoto for this interview!

For Information:
Pulstec Industrial Co.,Ltd.
7000-35 Nakagawa
Hosoe-cho, Kita-ku, Hamamatsu-city
Shizuoka Pref., 4311304, Japan
Tel. +81.53.522-3611
E-mail: y-teramoto@pulstec.co.jp
www.pulstec.co.jp/en/