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Introducing the PSMX-II

The new in-line residual stress measurement system by Sintokogio

DEAR READER... as you are aware, shot peening improves the fatigue strength of metal parts such as gears or springs. Shot peening improves fatigue strength through compressed residual stress.

Arc height, measured with Almen strips, is commonly used as a parameter for understanding the strength of the shot peening process. This method was developed in 1945 and it is widely used today.

The arc height and the residual stress have a correlation, but with the arc height it is not possible to know the exact value of the remaining residual stress in each part.

The Almen strip measurement method is good for monitoring the condition of the shot peening process. In order to know the residual stress value (in MPa); however, it is necessary to employ specific measurement equipment.

The existing equipment technology to measure residual stress value is too lengthy a process to be utilized in line and would cause a loss of production.

To solve this problem, Sintokogio developed an In-Line X-Ray Residual Stress Measurement device, the PSMX-II.

The PSMX-II

The PSMX-II uses x-ray technology to measure the compressive residual stress in shot peened pieces. This equipment was designed to work in-line, guaranteeing the process control of shot peening and providing the residual stress in each manufactured piece (Figure 1).

In addition to providing the level of residual stress, the PSMX-II identifies the Full Width Half Maximum (FWHM) and the size of the crystal grain.

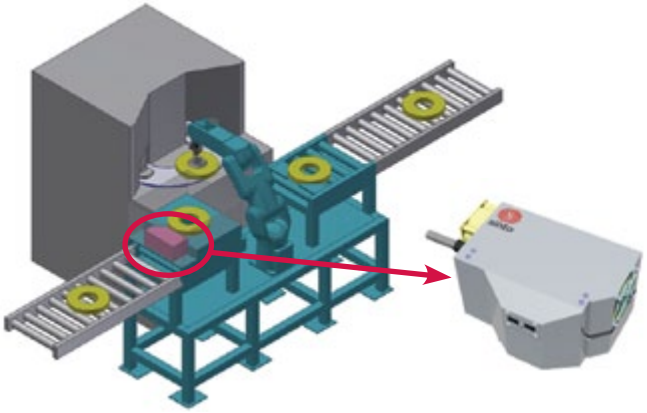

Figure 1. The PSMX-II is an in-line residual stress measurement tool that produces results in five to 10 seconds

The residual stress measurement time is between ***five and ten seconds*** and can be reduced further in certain parameters. This short measurement time is possible because the PSMX-II measures only the residual stress without any kind of analysis. The accuracy will change according to material, shape, measuring time and distance of the surface.

PSMX-II Applications

The PSMX-II can be used for in-line inspection of automotive parts, such as gears and springs, as a preventive inspection before the machining process in order to avoid the eventual high residual stress cause deformation in the piece after machining. The PSMX-II can also measure large parts such as wind turbine generators and construction equipment parts. Very high stress occurs in components made in large equipment such as the machine in Figure 2.

Figure 2.

If the part achieves the predefined residual stress, it proceeds to the next process. If the part does not achieve the predefined residual stress, it is removed from the line. The PSMX-II is easy to operate, fast, and ensures that only good parts will be processed.

The Measurement Process

The functions demanded of parts are their form (machining precision) and the mechanical properties of the materials, mainly material strength. Mechanical properties are parameters such as hardness and durability. Destructive

inspection has been necessary to measure these parameters. These processes were checked to see if they satisfied the predefined mechanical properties in the actual production line as construction took place. In order to do so, by utilizing devices for those processes, experiments are performed by changing each type of processing condition. Through this, we can confirm whether or not the processes satisfy the required mechanical properties. This is referred to as process capability assurance. With process capability assurance, specifications are not directly verified, but rather the process capabilities are secured as surrogate parameters.

For companies that internally handle the entire manufacturing process from the first step to the last (from materials to shot peening), if process capability assurance is performed at every step, residual stress measurement after the shot peening process may not be necessary. But for those companies that request outside handling for at least one step in that full process, there is the added work of verifying the process capabilities for delivered parts when they are received. For the final shot peening process, as long as residual stress is confirmed, that product's capabilities are satisfactory. Thus, confirmation of residual stress can be useful in improving quality control.

In addition, with the recent interest in IoT (Internet of Things), recording various parameters for the manufacturing process can be useful for the optimization of process design and the operation of the overall plant. To achieve this, even if process capabilities have been satisfied, PSMX-II can be used to check the residual stress of all parts, and improvement of product quality control can also be expected.

In Figure 3, the device is measuring the residual stress of the bottom of a gear that has undergone carburization heat treatment. Residual stress is generated by gears that have undergone proper carburization heat treatment, and by using PSMX-II, that residual stress can be measured. Additionally, if there has been an abnormality in the heat treatment, changes appear in the count rate and Full Width Half Maximum. This can be used to determine the quality of the parts. Of course, it also measures and records those parameters after shot peening has taken place. In addition, the acquired data can be sent to other devices, including a PLC.

Figure 3. A production process for transmission gears

Heat Treatment and the PSMX-II

There is a possibility of decarburization near the surface of the part after heat treatment. If decarburization occurs near the surface, the surface hardness will be reduced 0.2% proof stress depending on the hardness (Figure 4). Therefore, decarburized material will have lower residual stress. We can see the difference in residual stress between parts with and without decarburization (Figure 5). As you know, we can't find decarburization material by visual inspection. Now we can measure residual stress individually in the production line.

For more information on the PSMX-II, please send an email to Sightia@sinto.co.jp.

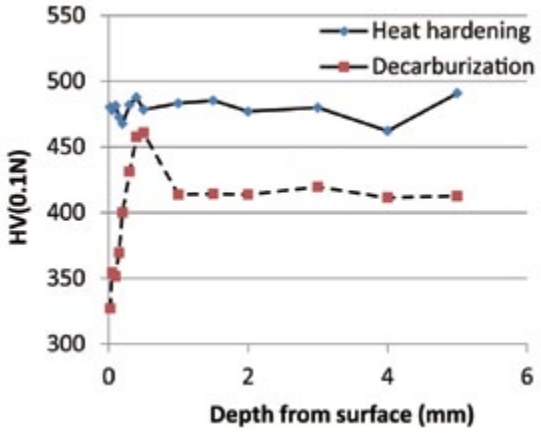

Figure 4

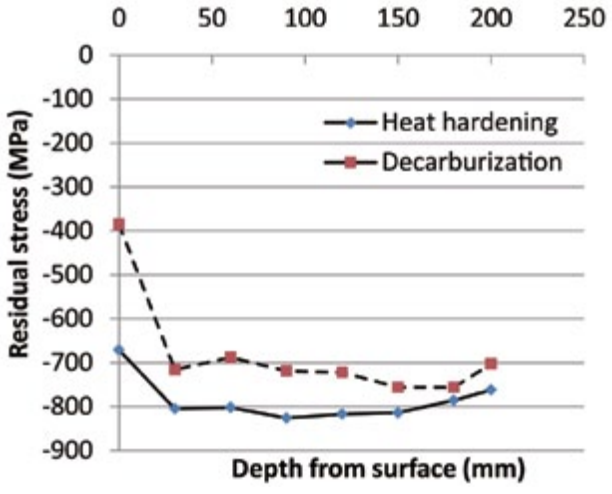

Figure 5