Coverage Measurement Innovation
From Determination to Numerical Analysis

QUALITY ASSURANCE for shot peened parts is mainly materialized with inspection of arc height intensity and coverage, or roughness, residual stress or hardness. As for appropriate coverage judgment, personnel have to be well-educated and experienced because accuracy depends on individual capability. If coverage testing is performed with insufficient accuracy, it will undermine the value of coverage as a guarantee of quality.

Two years ago Toyo Seiko Co., Ltd. developed a coverage measurement device called the Coverage Checker™. Inconvenience in the calibration process has prevented its spread. In this report, a simplified calibration process is explained and two types of calibration line for flat and curved surface are enumerated.

MAKING A RECIPE
Coverage Checker needs calibration data for the correlation between the given coverage percentages measured visually and the pixel counts of binarized image. This calibration data is called a "Recipe." Before making a Recipe, a complete coverage (100% coverage) sample and more than one incomplete coverage (50-90%) samples are necessary.

A Recipe process consists of setting measurement conditions and creating a calibration line. With the latest Coverage Checker, setting conditions are simplified and easier to understand. Setting measurement conditions consist of three steps: exposure value, threshold and minimum area. The procedures respectively for a flat surface and a curved surface are shown as below.

Setting Measurement Conditions for Flat Surface
The first step to making a Recipe is the exposure value has to be set with a complete coverage sample. In setting exposure value window (Fig.1), histogram of brightness can be expressed with a resolution of 256. While confirming this histogram, adjust exposure value to make the histogram peak a little bit lower than the middle value (127).
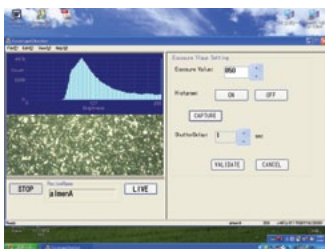

Fig.1 Setting exposure value window

Then, set the threshold that is a standard value for binarization to identify peened area and non-peened area. For threshold setting, an incomplete coverage sample shall be used.

In threshold setting window (Fig.2), choose sectional brightness graph. While confirming the graph, adjust the minimum value of threshold. Brightness on red line is shown in the window.
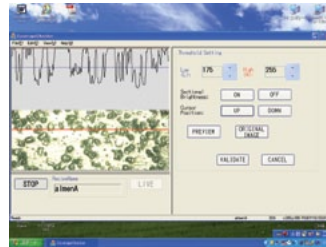

Fig.2 Setting threshold window

Since the center part of the peened dent will form a face parallel to the non-peened area, it will be captured white like the non-peened area. These areas are noise. Therefore, the area whose pixel number is less than certain level is omitted. In minimum area setting window (Fig.3), set the size to be eliminated from measurement object.
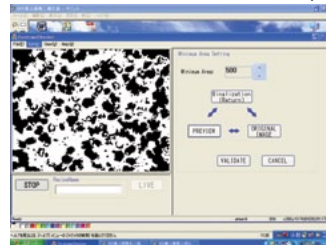

Fig.3 Minimum area setting window

Setting of measurement parameter is completed. Then with coverage samples visually inspected, the Recipe is made as shown in Fig.4 with five samples. Horizontal axis represents visual coverage percentage and vertical axis represents white pixel counts.
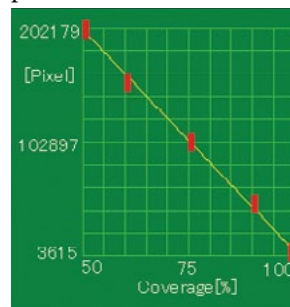

Fig.4 Recipe (calibration line) for flat surface

Setting Measurement Conditions for Curved Surface
A curved-surface image has a different characteristic than a flat surface. Non-peened area is captured black. As much as coverage value rises, white increases due to diffused reflec-

tion. A Recipe is made by focusing on this characteristic. First, exposure time is set. Like for the flat surface, exposure time is adjusted to make histogram peak close to the middle value (127) with a complete coverage sample. Example is shown in Fig. 5.
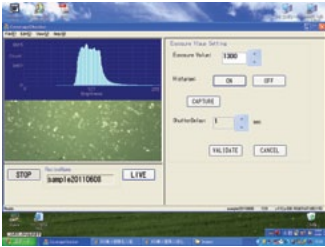

Fig.5 Setting exposure value window

Then, threshold value is set. For threshold setting, incomplete coverage sample is used. Sectional brightness graph is called. Set the low value of the threshold at the position that does not come in contact with the base curve of brightness. The example is shown in Fig.6.
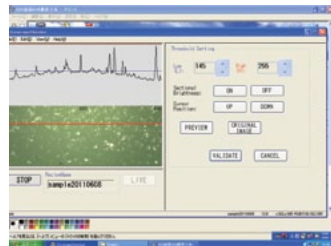

Fig.6 Picture of setting threshold for curved surface

For curved surface measurement, the minimum area is set in 100 pixels or less.

Setting of measurement parameter is completed. With coverage samples visually inspected, Recipe is made as shown in Fig.7. Differ from flat surface measurement, graph leans upward to right. Comparing to flat surface measurement, vertical range becomes narrow. The radius of the curved surface smaller, the range of pixel counts narrow then it effects measurement accuracy. Therefore, the radius of curvature to measure recommends more than 0.15″.
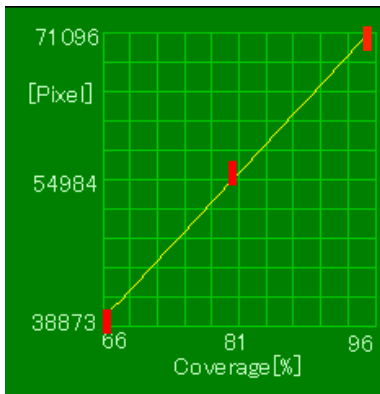

Fig.7 Recipe (calibration line) for curved surface

INTRODUCTION OF IMPROVED POINTS
Focus Adjustment Tool and Nozzle

With this tool, it is easier to adjust focus with good repeatability especially on curved surface, for example coil spring and stabilizer (made of round bar). Also the head of nozzle is improved to fit on curved surface. The appearance is shown in Fig.8. Focus adjustment processes are shown in Fig.9.

Fig.8 Focus adjustment tool and new nozzle

Fig. 9-1) Fix the position of Focus adjustment tool against surface to measure

Fig. 9-2) Adjust the nozzle length with Focus adjustment tool

Fig. 9-3) Measure the coverage

Saving Data and Installing the Program

Results that include capture image and Recipe name can be saved onto a hard disc. This will make daily quality control easier.

Coverage Checker software can be installed on Windows-based PCs with a CD-ROM provided in the new Coverage Checker set. The set includes the Coverage Checker, focus adjustment tool, nozzle and software CD-ROM. The software can be installed on an unlimited number of the customer's PCs. ●