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Suggestion of Image Processing System for Measurement of Coverage

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INTRODUCTION

Generally speaking, the management of shot peening would be conducted by arc height intensity, coverage and deformation of part. As standard method of measurement of coverage, it should be required to use the strip that has the same hardness and material of the target. However, usually normal almen strip is used in place of correct specimen for coverage measurement.

At standard method of coverage measurement, it is required to calculate by checking the weight rate of piece that was cut from an enlarged photo. Further at simplified method it is requested to decide the coverage by comparing with the standard photo. The former method takes a longer measurement time and the latter is basically depend on the skill.

So, in this paper we would suggest new measurement method to avoid above two problem by using mirror polished almen strip and image processing.

OUTLINE OF COVERAGE MEASUREMENT (Fig. 1)

1. Prepare mirror polished almen strip that has no defect by processing and polishing
2. Shot peening treatment to polished almen strip
3. Take enlarged digital photo with 30 times magnification by optical microscope
4. By using image processing, make a binarization of surface condition
5. Calculate coverage by monitoring the dent area

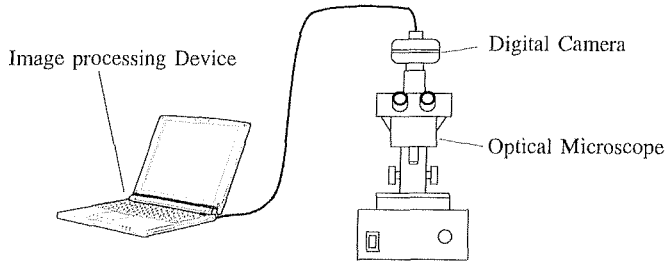

Fig.1 Appearance of image processing system

EXPERIMENTAL PROCEDURE

Table 1 shows shot peening conditions. In order to make the different coverage sample treatment time had been controlled. Fig.2 shows four kinds of the image data. In this figure white area indicate the dent by shot peening and black area shows non-injected area. To distinguish the injected area from unprocessed area we conducted the binarization for the image data. However, it is considered that coverage value is strongly depend on the set of binarizaton and this setting for binarization is affected by

Table 1 Shot peening conditions

Equipment	Air Type
Shot Media	RCW06PS(0.6mm dia., HV720)
Air Pressure	0.2 MPa
Nozzle Size	9mm dia.
Injecting Volume	7 kg/min

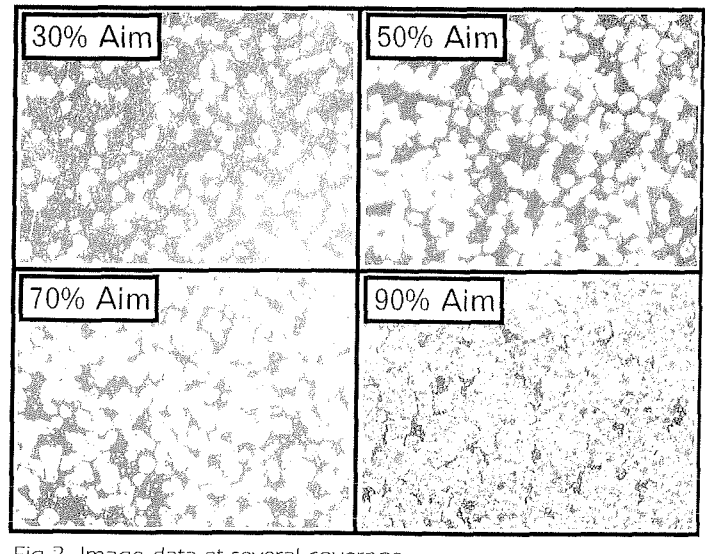

Fig.2 Image data at several coverage

accuracy of image data. So, in order to confirm the effect of binarization on coverage value, we selected several setting value for binarization.

METHOD OF TAKING PHOTO

As the method of illumination to almen strip, we used light source at outside of microscope. And this beam is not parallel with optimal scope beam. In this case, incident beam should be reflected randomly to the lens at microscope, so that we could recognize the peened dent as white. On the contrary, reflected beam from untreated area should be reflected perfectly, so that we could not confirm any beam. This means that we would see only black image. By the way, in order to calculate accurately, it is important to distinguish white area from black after binarization, especially boundary. Fig.3 shows the enlarged image photo taken at automatic exposure time and extend exposure time. And cross section of concentration profile at dent zone is shown in Fig.4. At left hand photo, we could confirm the black area at inside the actual dent zone. Further we could see uneven profile inside the dent zone in Fig.4 left hand. On the other hand we could easily confirm the entire white area at extend exposure. And also there is no uneven profile at cross section of concentration profile.

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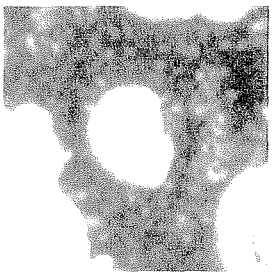
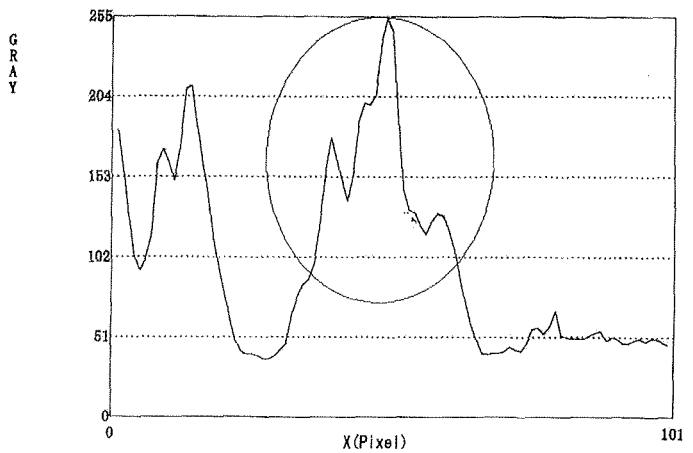
3 (a) Automatic exposure

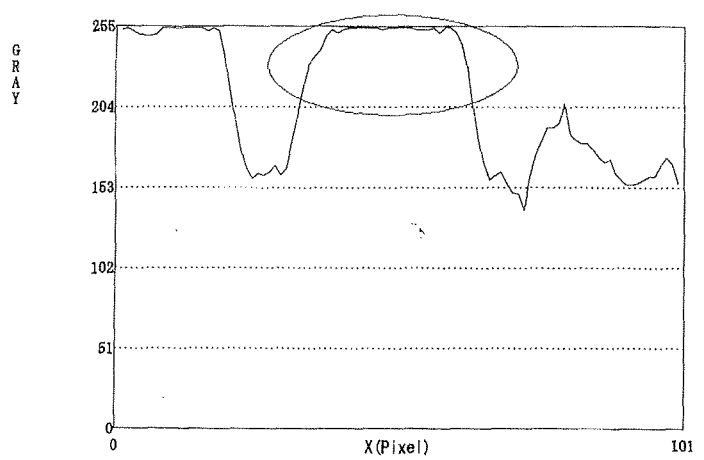


3 (b) Extend exposure

Fig.3 Effect of exposure time on image data



4 (a) Automatic exposure



4 (b) Extend exposure

Fig.4 Cross section of concentration profile at dent zone

METHOD OF SETTING A THRESHOLD VALUE

Automatic setting system (mode method) for threshold value was adopted in this study (see Fig.5). At mode method threshold value is decided by finding the value at the trough of histogram that cover the entire area. However it is difficult to find the trough at Full coverage sample because there is no trough due to existing a lot of white area. So, we selected localized area that share half and half with injected area and recalculated the threshold value at that localized area. Further we conducted the same method at another five localized area and finally the average value was adopted. Fig.6 shows the comparison between entire evaluated area and localized area with a threshold value. As we could

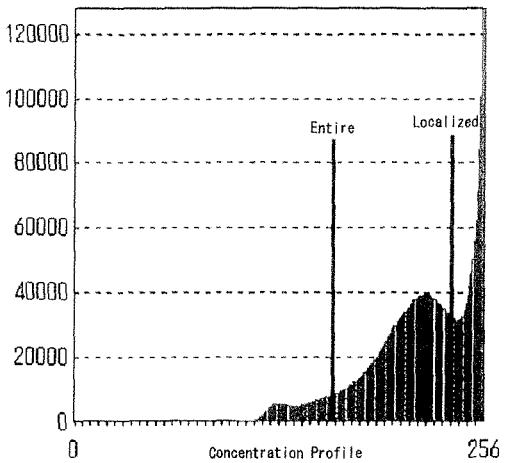
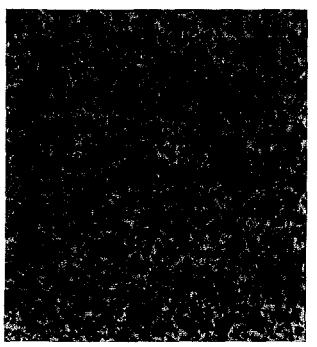
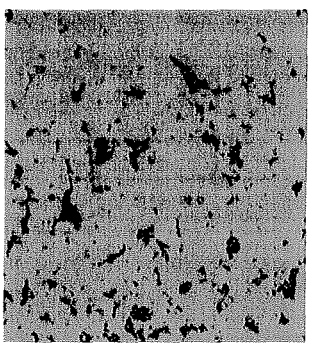


Fig.5 Histogram of image data (coverage 90% sample)



6 (a) Entire area



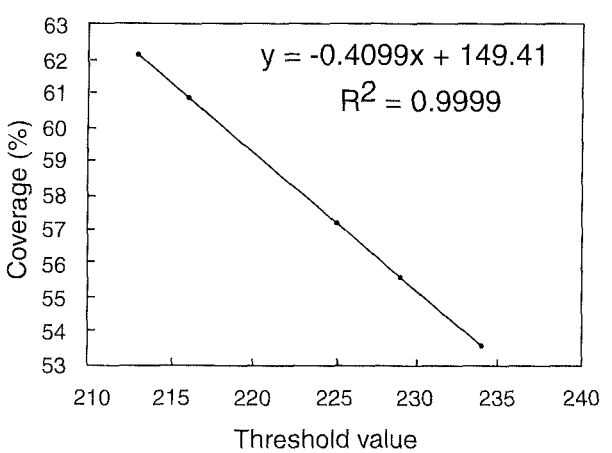
6 (b) Localized area

Threshold value = 167 Threshold value = 230

Fig.6 Effect of evaluated area to decide threshold value

confirm easily the value was quite different and localized value seemed to show very close to actual phenomenon. As the results, we recommend to evaluate the localized area because we could distinguish easily injected area from untreated area.

Fig.7 shows the relation between calculated coverage and selected threshold value at 50% and 90% coverage sample. We could confirm linier relationship. Declination rate at 50% sample was 0.4 and 0.2 at 90% sample. This means that calculated coverage value has 4% tolerance due to the changing threshold value of 10 at 50% sample. Also 2% tolerance at 90% coverage.



7(a) 50% coverage

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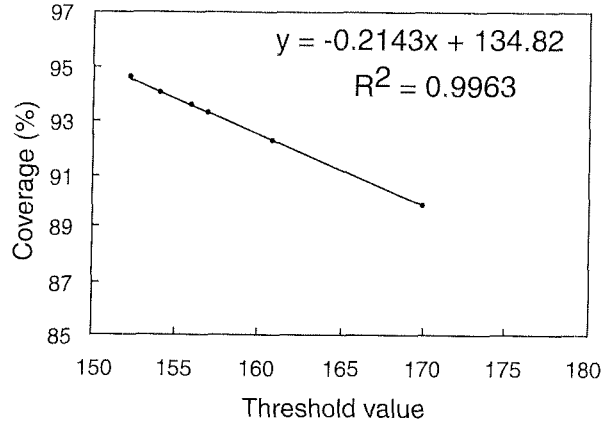

7(b) 90 coverage

Fig.7 The relationship between coverage and threshold value

QUANTITATIVE ANALYSIS

First of all in order to confirm the effect of human error, threshold value was selected by ten engineers at this method as mentioned before. Table 2 shows the results of this evaluation. We could confirm that the threshold value was almost same and it was concluded that this method could avoid human error compared to conventional method.

By using of 90% coverage sample we conducted the comparison of results between this method and conventional precise method (weight rate of paper cut as mentioned before). Coverage at this method was 93.2% and 92.1% at conventional. So it was confirmed that this image processing method is very useful to avoid human error and indicate the actual coverage value.

CONCLUSION

A. Threshold that decide the boundary among injected area, dent and untreated area should be selected at several localized image data with extend exposure.
B. There was linier relationship between coverage and threshold value.
C. Coverage was calculated objectively by using suggested method of threshold value.
D. Coverage value by this method was quite same as the conventional standard.

Table 2 The results of selected threshold value

Threshold Value (n=20)				
224	221	216	222	225
233	217	233	235	223
230	218	235	229	216
234	220	231	230	220

max.	235	Ave.	225.6
min.	216	Std. Deviation	6.7