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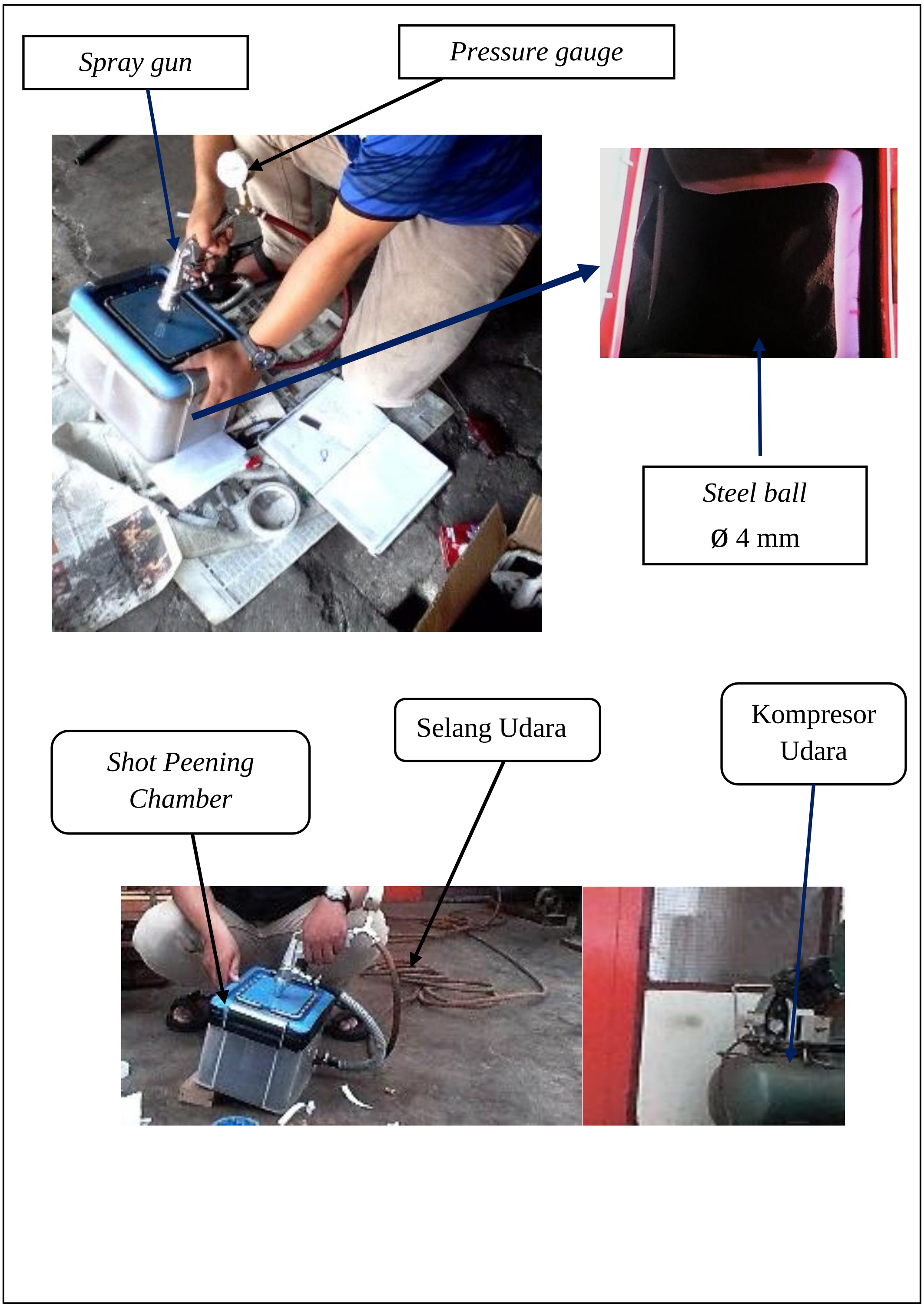
LAMPIRAN

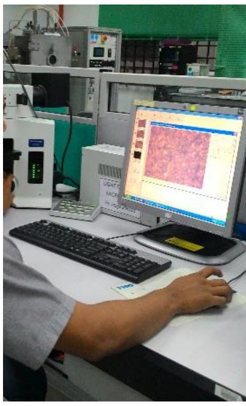
Lampiran 1 Proses *Shot Peening*



Lampiran 2 Proses Pengujian Struktur Mikro

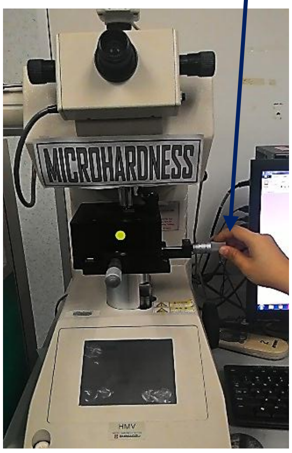
Persiapan material

Proses karakterisasi

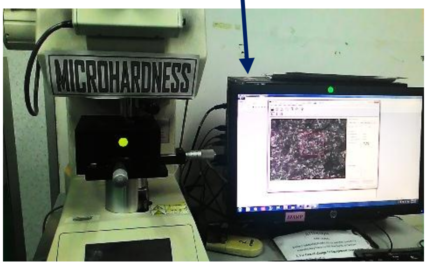


Lampiran 3 Proses Pengujian Kekerasan *Vickers*

Set Up sampel



Proses pengambilan data



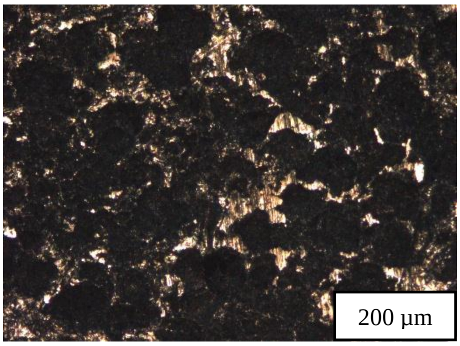
Lampiran 4 Proses Pengujian Kekasaran Permukaan

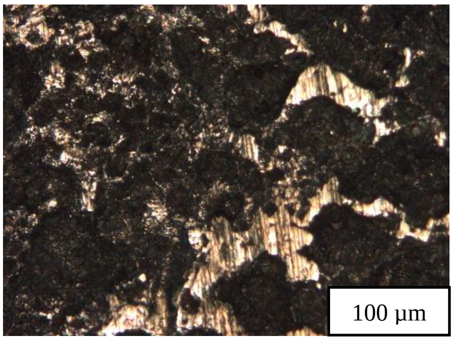
Proses pengujian

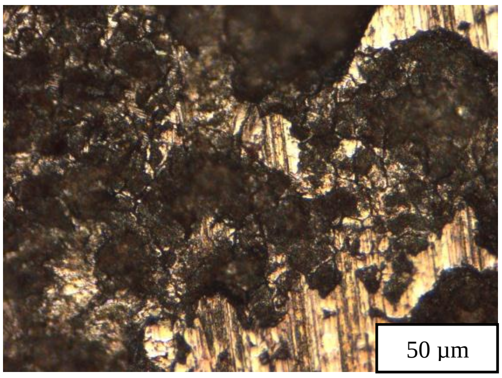
Proses pengambilan data

Lampiran 5 Hasil Struktur Mikro

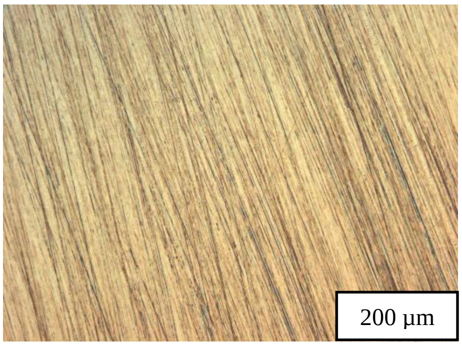
Raw material

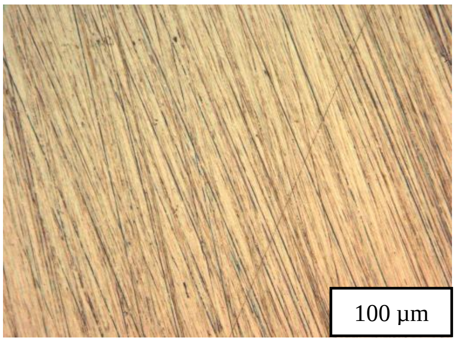


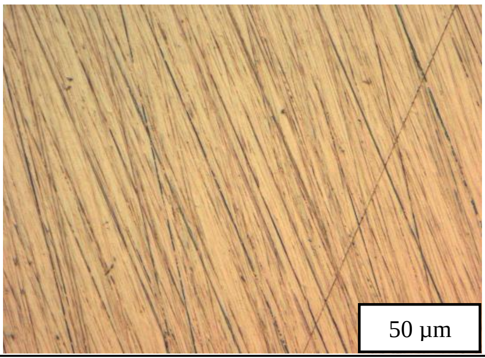




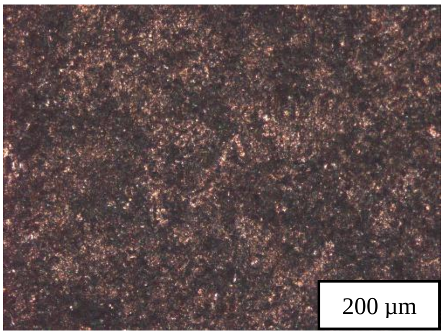
Raw material after grinding

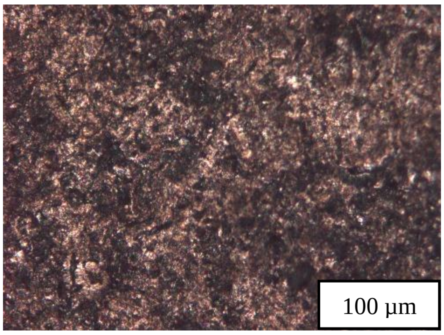


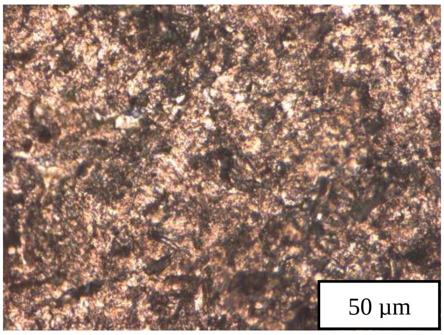


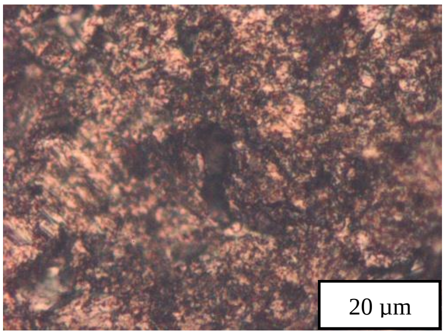


Shot peening 9 menit

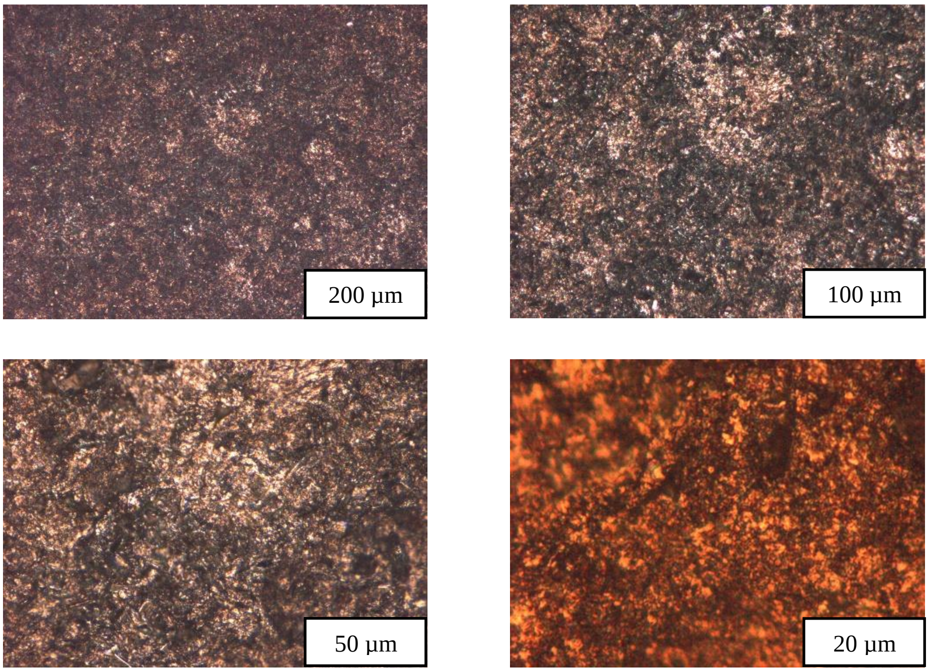




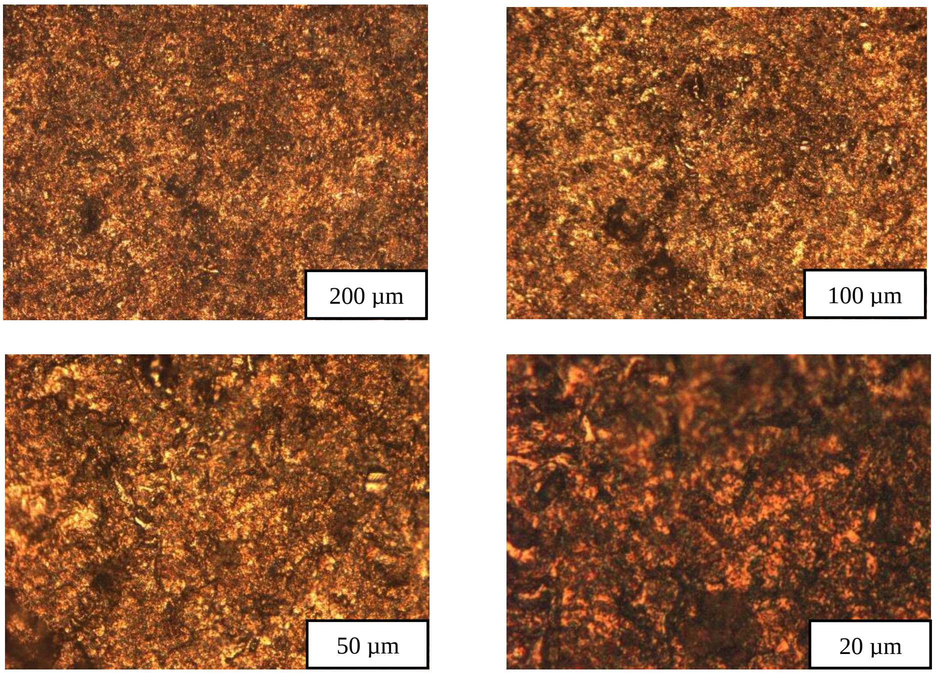




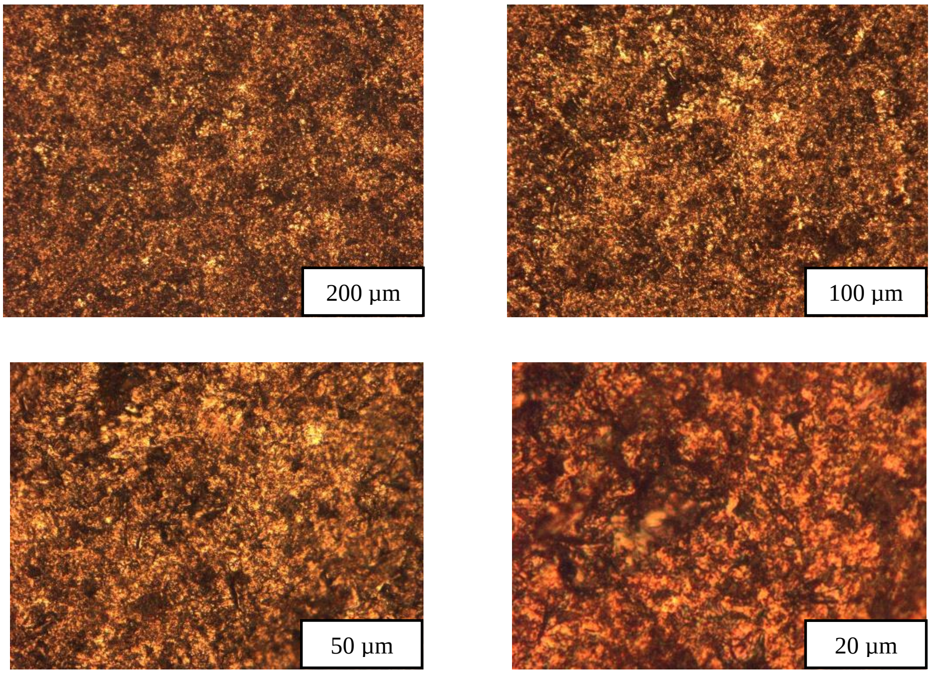
Shot peening 10 menit



Shot peening 11 menit



Shot peening 12 menit



Lampiran 6 Data Pengujian Kekerasan

Waktu (menit)	0	9	10	11	12
Data Pengujian (HV)	100	164	169	182	198
	102	161	173	170	195
	104	167	165	172	188
	103	166	164	174	209
	101	164	166	178	209
Rata-rata	102	164.4	167.4	175.2	199.8
Standar deviasi	1.581139	2.302173	3.646917	4.816638	9.14877

Lampiran 7 Data Pengujian kekasaran Permukaan

Waktu (menit)	0	9	10	11	12
Data Pengujian (µm)	0.45	1.07	1.090	1.14	1.15
	0.55	1.11	1.100	1.18	1.19
	0.50	1.09	1.095	1.16	1.17
Rata-rata	0.50	1.09	1.095	1.16	1.17
Standar deviasi	0.070711	0.028284	0.007071	0.028284	0.028284

Effect of Time Variation on Shot Peening Process to the Surface Properties of SS-316L Osteosynthesis Plate

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Keywords: Microstructure, Osteosynthesis Plate, Shot peening, SS 316L.

Abstract. Shot-peening is one of the surface modification methods to increase material hardness and smoothen its surface at the same time. SS-316L, one type of biocompatible material, is commonly used in medical field particularly for joining fractured bones. However, the surface-crack-prone characteristic of SS-316L has limited its application to be used for such application. In this research, steel balls with diameter 0.4 mm is subjected to the surface of SS-316L Osteosynthesis Plate with variation of time; 9, 10, 11 and 12 minutes holding at constant pressure of 6 bar. The nozzle-to-plate distance is fixed at 100 mm. The impact of the shot balls is a deformed surface and produces a flat-like structure on osteosynthesis plate shot in 12 minutes time. The result shows that shot peening of SS 316L gives its best microstructure after 12 minutes of treatment.

Introduction

Development characteristic on orthopedic tools increases according to the trend of orthopedic problems in recent years [1-6, 8-10, 12-14]. Biomaterial is not only used for orthopedic devices but also for making implants. Orthopedic implants are made of synthetic materials used to replace or stabilize bone which has defect [3]. Biomaterials available up to date are titanium, silicone, apatite, and stainless steel. The advantages of using stainless steel, in this case is SS-316L, are anti-corrosive, lightweight, tough but easy to shape. SS-316L is an austenitic metal which less magnetic and has less carbon content [4-5, 13-14]. Mechanical properties of this metal is lower than titanium, hence SS-316L needs to be treated to increase its strength. SS-316L cannot be heat-treated since its carbon content is low, hence cold-working treatment become a solution [6, 15]. The metal is cold-treated by pressing its surface by mechanical means to deform the surface plastically. Cold treatment option can be done by machining, sandblasting, shot peening, etching, anodizing, and Surface Mechanical Attrition Treatment (SMAT).

Shot peening is a technique to smoothen the particle size at the surface. The process is illustrated in Figure 1. This process uses abrasive steel balls, shot the workpiece's surface at high pressure [1-7, 15]. The impact increases the metal's mechanical strength at the surface. Investigation of shot peening effect to SS-316L is still limited up to date. This research aims to investigate the effect of shot peening to the microstructure, hardness, and surface roughness of SS 316 L surfaces which will further be used for making osteosynthesis plate.

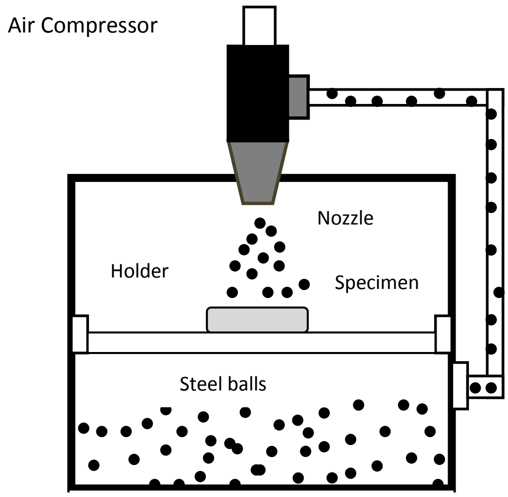


Fig. 1 Shot peening

Materials and Methods

Sample was prepared from SS 316L plate with dimension of 105mm x 12 mm x 4mm. Figure 2 shows the plate design and the prepared plate prior shot peening treatment. The specimens were mechanically polished prior shot peening to obtain uniform surface condition. The experimental set-up for the shot ball treatment in this study is illustrated in Figure 1 [2]. The steel balls with diameter 0.4 mm were blasted in normal direction toward the work surface for 9 to 12 minutes using bar- compressed air flow [1-3]. The nozzle diameter 10 mm was used for treatment; and the distance of nozzle to plate was maintained at 100 mm. The pressure is fixed at 6 bar.

The surface structures were observed using a Scanning Electron Microscope (SEM) Table Top (Wrexham, U.K.) to identify the traces on the surface created by the impact of milling balls. The samples surface roughness was quantified using a contact stylus profilometer (Wrexham, U.K.). The measurement was conducted on 5 different locations to obtain the arithmetic medium value (Ra) of the samples.

(a)

(b)

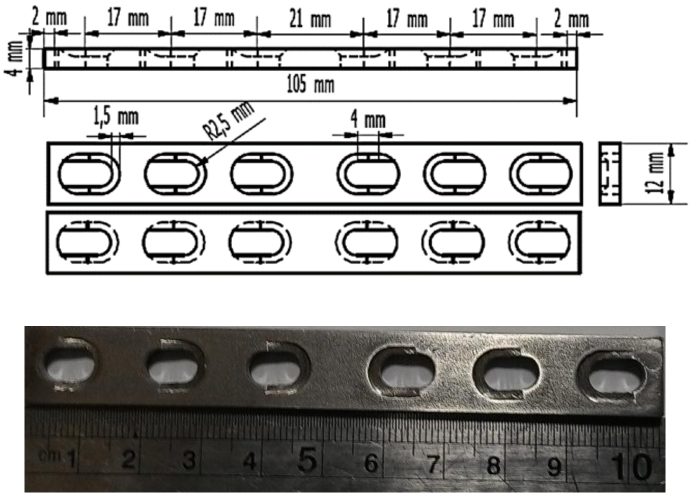
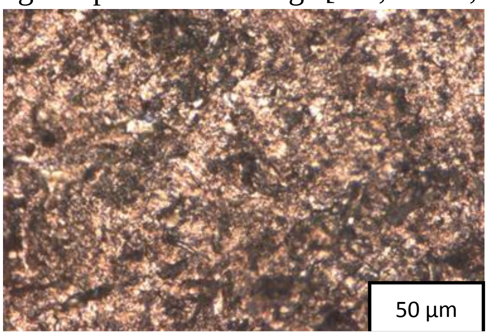


Fig. 2 (a) Plate design (b) SS-316L specimen prior treatment

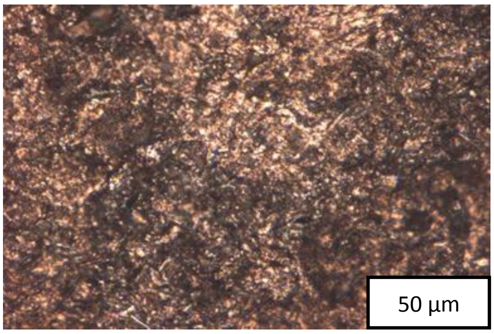
The effect after shot peening treatment can be simply observed on the distribution of microhardness over the cross sectional area of the samples [8-9]. For this purpose, each sample was cut laterally after the treatment to expose its cross-sectional area at which the measurement was conducted. The microhardness at several points closer to the surface layer was measured using a microhardness tester (Wrexham, U.K.) with an indenting load of 980.7 mN in 5 seconds time.

Result and Discussion

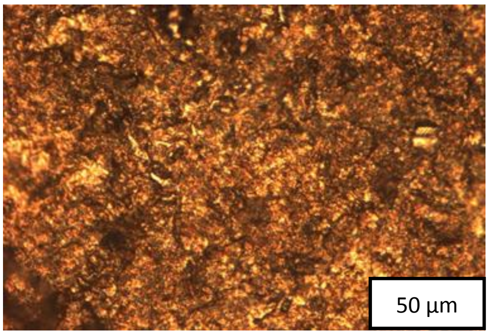
Figure 3 presents the micrographs of specimen surface after treatment. Fig. 3(a) shows the surface micrograph after 9 minutes shot peening process. The surface shows insignificant change to the surface after polishing. Fig. 3(b) is the surface after 10 minutes treatment. It starts to show some small change on its microstructure. The surface after 11 minutes treatment in Fig. 3(c) shows a relatively uniform surface with shaggy appearance. Fig. 3(d) shows the surface micrograph after 12 minutes treatment where surface tends to form scratches. From the micrographs analysis, it can be concluded that shot peening with 6 bar pressure gives its best surface microstructure at 11 minutes treatment which agrees previous findings [1-2, 10-11, 15].



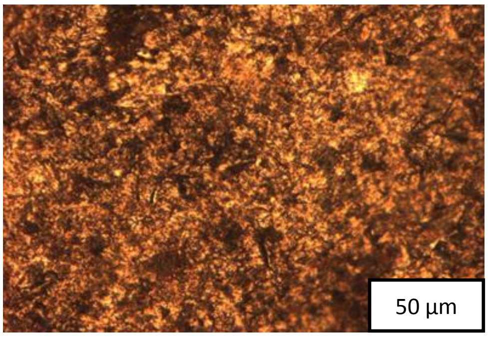
a) *Shot peening* 9 menit



b) *Shot peening* 10 menit



c) *Shot peening* 11 menit



d) *Shot peening* 12 menit

Fig.3. Surface morphology of the specimen after the shot ball treatment using steel balls.

Figure 4 presents the effect of time variation to the microhardness of the plate. Before treatment, the microhardness is at the range of 90–100 HV. After shot peening treatment, the microhardness increases to the range of 160–200 HV. The graph indicates that the optimum microhardness value is reached after 12 minutes treatment.

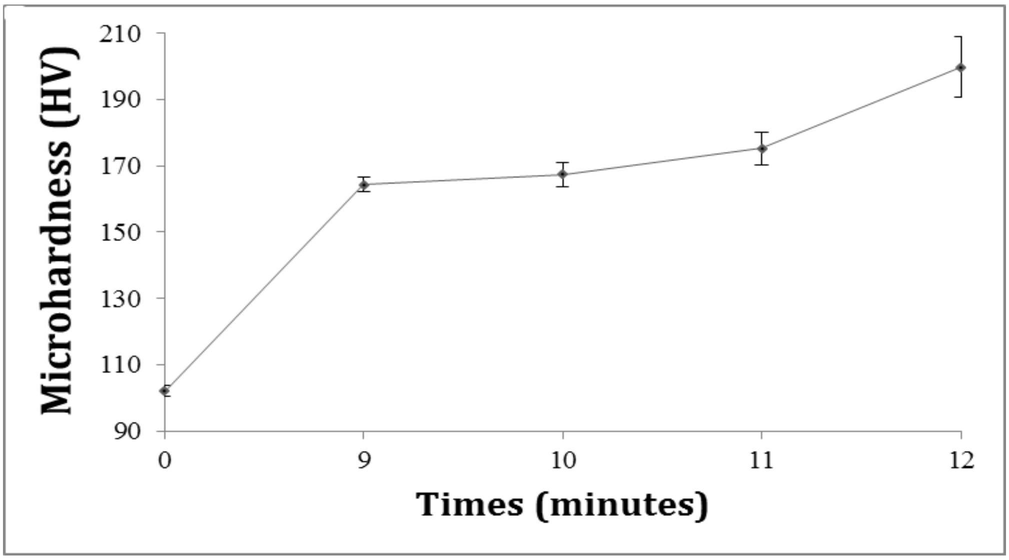


Figure 4 Measurement of microhardness with varied shot peening treatment applied.

Figure 5 shows the surface roughness measurement of the treated plates. The roughness increases proportionally to its microhardness value. The roughness measurement is at its peak at 12 minutes treatment and relatively steady after 12 minutes.

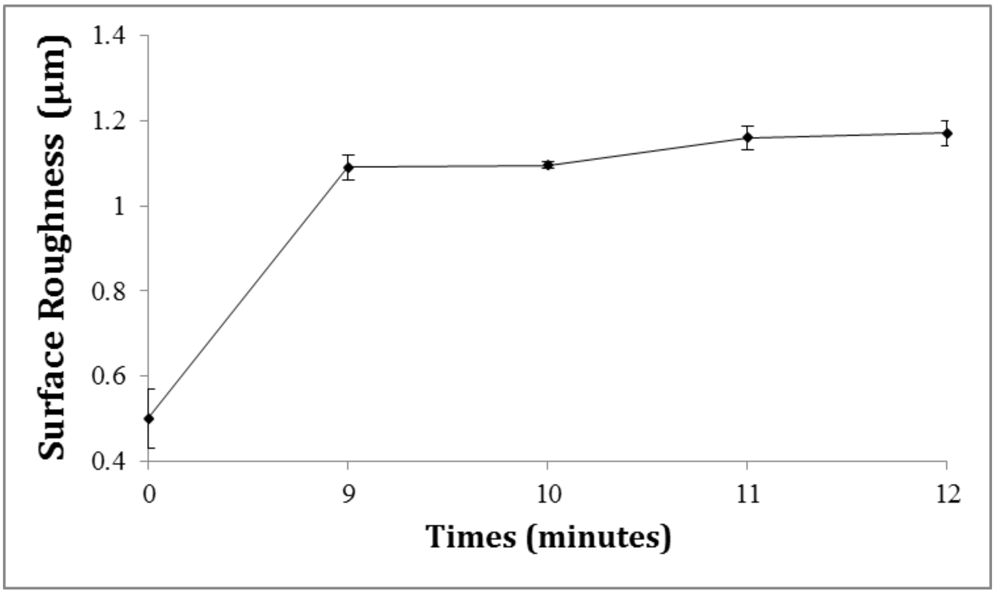


Figure 5 Measurement of surface roughness.

Conclusion

This research aims to investigate the effect to shot peening duration to the surface properties of osteosynthesis plate. The pressure is fixed at 6 bar and the shot time was varied from 9 to 12 minutes time. The experimental result shows that the shot peening treatment changes the surface properties of the osteosynthesis plate due to the impact of the steel balls. The optimum microhardness and surface roughness measurement was reached after 12 minutes treatment when applying 6 bar pressure onto the plate surface.

Acknowledgement

We would like to thank Balai Latihan Pusat Teknik (BLPT) Yogyakarta and Balai Pengembangan Teknologi Tepat Guna (BPTTG) Yogyakarta for providing some assistance in this project.

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