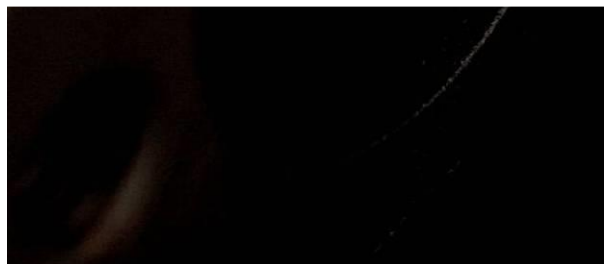




2019-010

# Examination of laser treated aluminium

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## 1 IPK412-02

## 2 Examination of laser treated aluminium

### 2.1 Background

To test a new laser equipment Åsa Lundevall has treated two different aluminium alloys.

### 2.2 Aim

Investigate effects of laser treatment on aluminium alloys. This is an “trial and error” experiment.

### 2.3 Experimental procedure

Two sets of aluminium specimens were tested; one set with HPDC samples cast at Ljunghälls and one set of specimens cut from a cast component. Test pieces were sent to Åsa Lundevall, she decided what parameters to use for the laser treatment. The results are shown in the following figures.

### 2.4 Summary

The laser treatments of the surfaces have influenced the surface appearance and the microstructure. The effect on the surface appearance is shown in Figure 6. Examination of cross sections revealed a 3-10 µm thick layer of, what appears to be aluminium (based on ocular examination), has formed. The examination in the SEM-EDS gave no answer on the composition of the surface layer formed.

Information from Åsa Lindervall:

På **Ljunghälls gjutna Al-detaljer** (Marie och Andreas prover) så har jag först gjort en provplatta med olika parametrar där ni kan se en större variation bland effekter som kan åstadkommas. F2 visar en bredd från hög till låg pulsfrekvens. F3 visar på 10 parametrar av den halvan av de snällare parametrarna. F5 visar istället på 10 parametrar av den halvan av de tuffare parametrarna hos F2. Den sida som är markerad 0 utgår från den mildaste behandlingen och 9 motsvarar den tuffare behandlingen och så går det stegvis upp mellan dem. 4 olika nivåer har valts ut till större ytor det är 200kHz som finns vid 0 på F2, 50kHz som finns vid 9 på F2, 152kHz som finns är markerad på F3 och 98kHz som är markerad på F5.

**Aluminium Swecast 190206** har jag gjort 10 små rutor på en som motsvarar F2 dvs behandling i både X och Y-riktningen från 200kHz pulsfrekvens (mild) till 50kHz (hård). Därefter har jag valt ut 200kHz och 98kHz som är nr6 i ordningen och man räknar 200 som O:a. Dessa har jag använt på en större yta på var sin bit.



Figure 1. A HPDC test plate with various laser treatments. The backside of this palate was not treated by the laser. The size of the plate is about 60x70mm.

Figure 1 show a HPDC test plate with various laser treatments. Three different sets of treatments were performed and named F2, F3, and F5.

F2: is from low to high pulse frequency.

F3:



(a)



(b)

Figure 2. Test plate 2. Front side treated with 98kHz and backside treated with 50kHz.



(a)



(b)

Figure 3. Test plate 3. Front side treated with 200kHz and backside treated with 152kHz.

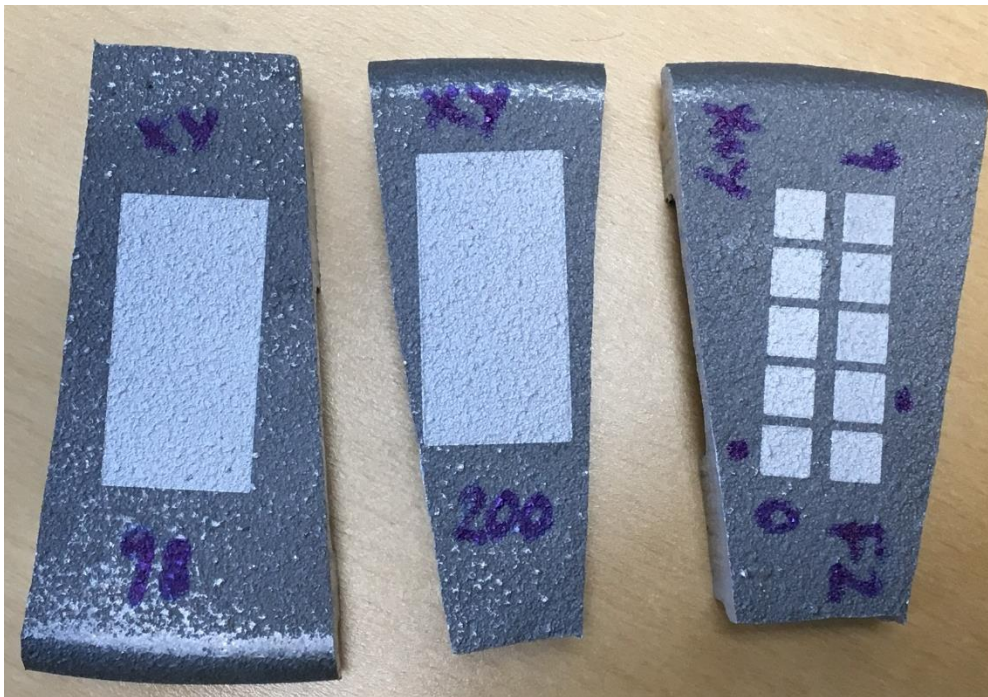
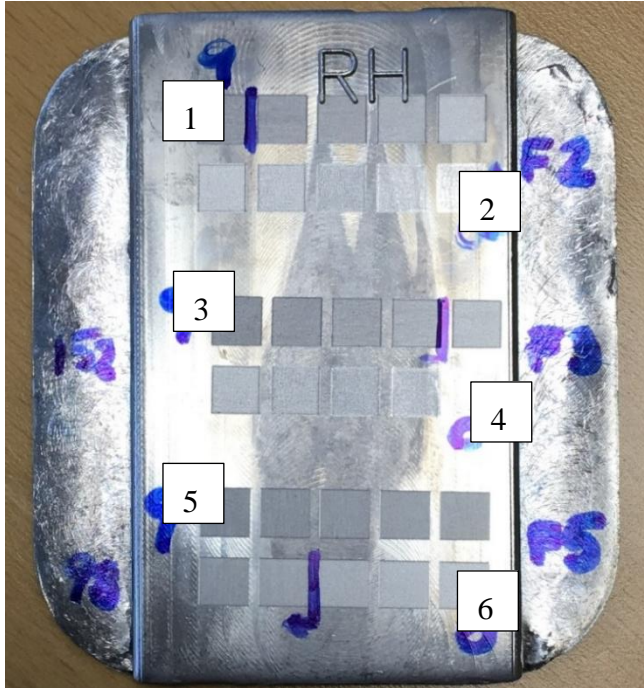


Figure 4. Test specimens cut from a sand cast component. The size of the plates are about 30x65mm.

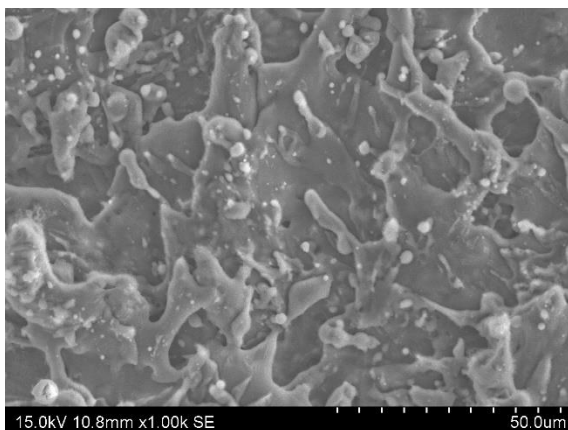
### 3 SEM Examination

The HPDC sample seen in Figure 1 was examined in the SEM. Six laser treated squares were examined. The squares chosen were numbered 1 to 6 and the positions of the squares are shown in Figure 5.



*Figure 5. Marking of areas examined in the SEM.*

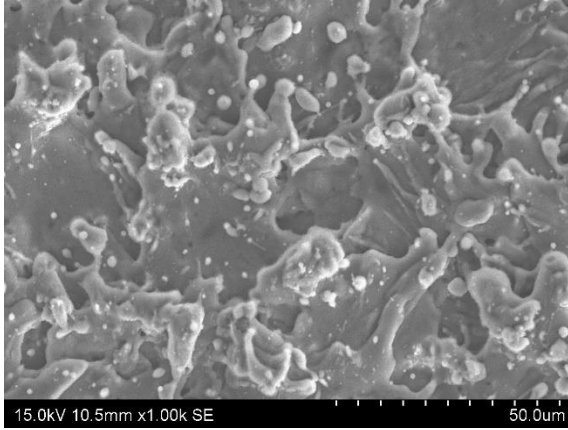
Images from the SEM examination are shown in Figure 6.



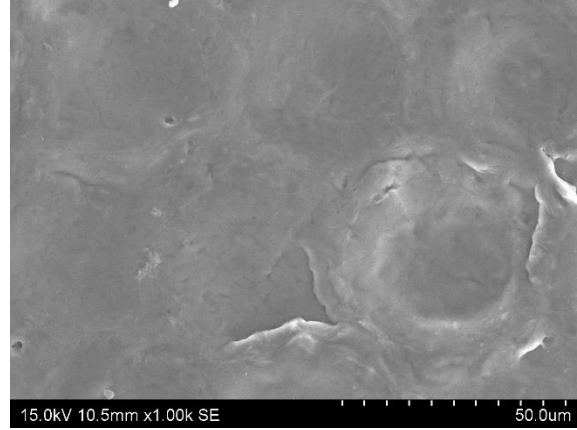
*(a)*



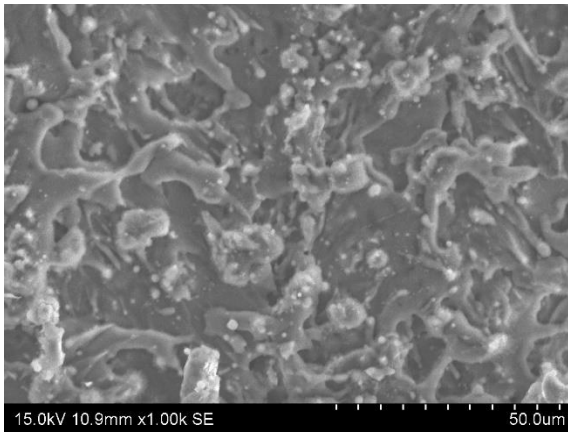
*(b)*



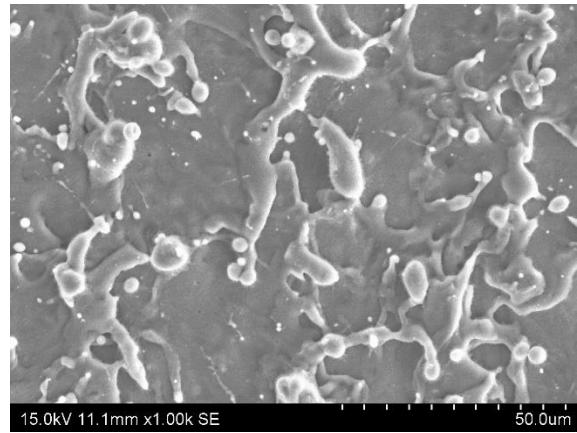
(c)



(d)



(e)



(f)

Figure 6. Images of six examined areas. (a) Area 1, (b) Area 2, (c) Area 3, (d) Area 4, (e) Area 5, and (f) Area 6. Original magnification 1000x.

### 3.1 Examination with light optical microscope

Sample ID	Note
sand 98	Sand cast sample treated with 98kHz laser.
sand 200	Sand cast sample treated with 200kHz laser.
HPDC 98 – 50	HPDC sample treated with 98 and 50 kHz laser.
HPDC 200 - 152	HPDC sample treated with 200 and 152 kHz laser.



Figure 7. Cuts made before mounting and preparation for examination in light optical microscope.

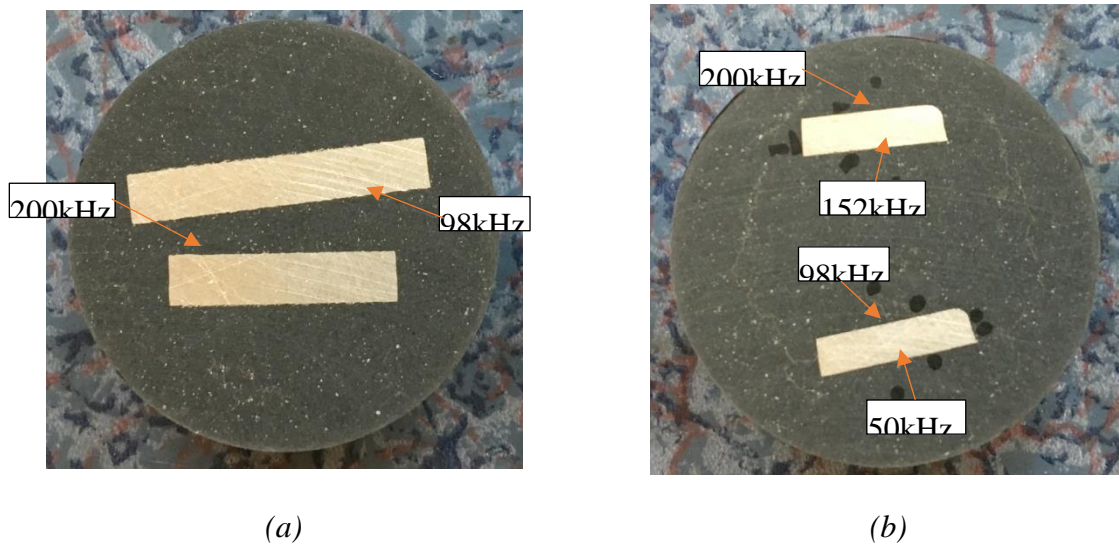
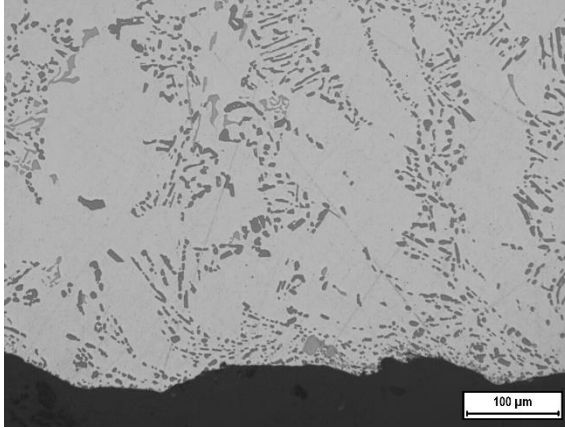
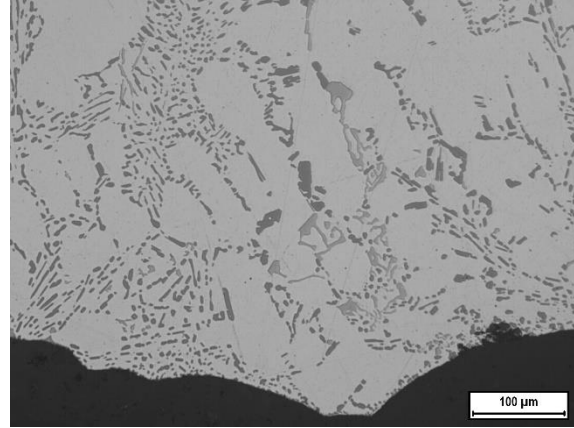
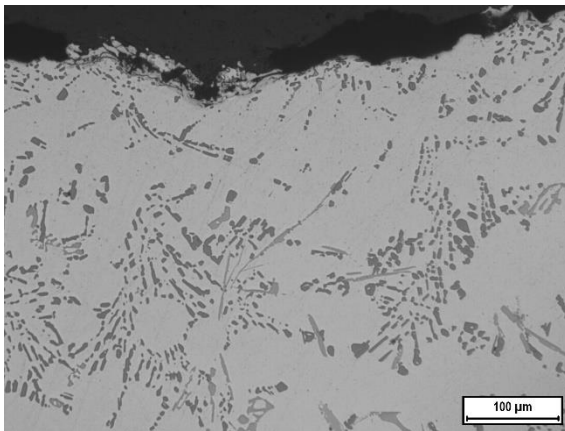
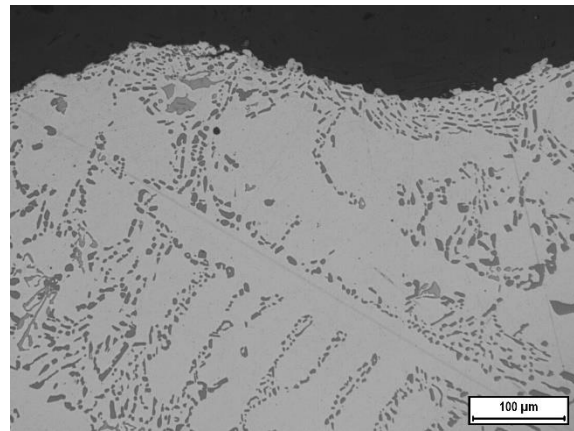
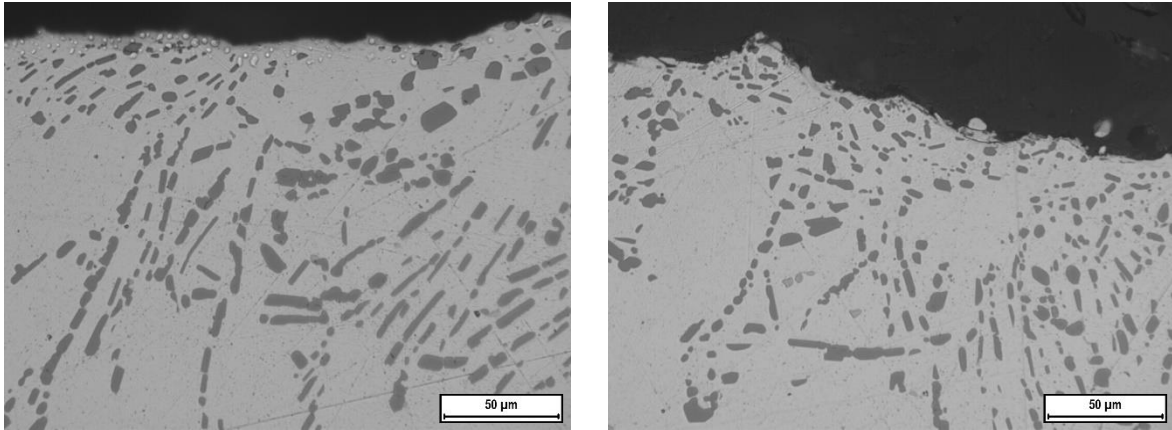


Figure 8. Images of the mounted samples with the pulse frequency of the laser. (a) sand cast component, the long sample was treated 98kHz (sand 98) and the shorter specimen

was treated with 200kHz (sand 200). (b) The HPDC, the side with rounded corner of the longer sample (HPDC 95 – 50) was treated with 98kHz and its opposite side was treated with 50kHz. The side with rounded corner of the shorter sample (HPDC 200 – 152) was treated with 200kHz and its opposite side was treated with 152kHz.

**Sand 98***(a)***Sand 200***(b)**(c)**(d)*



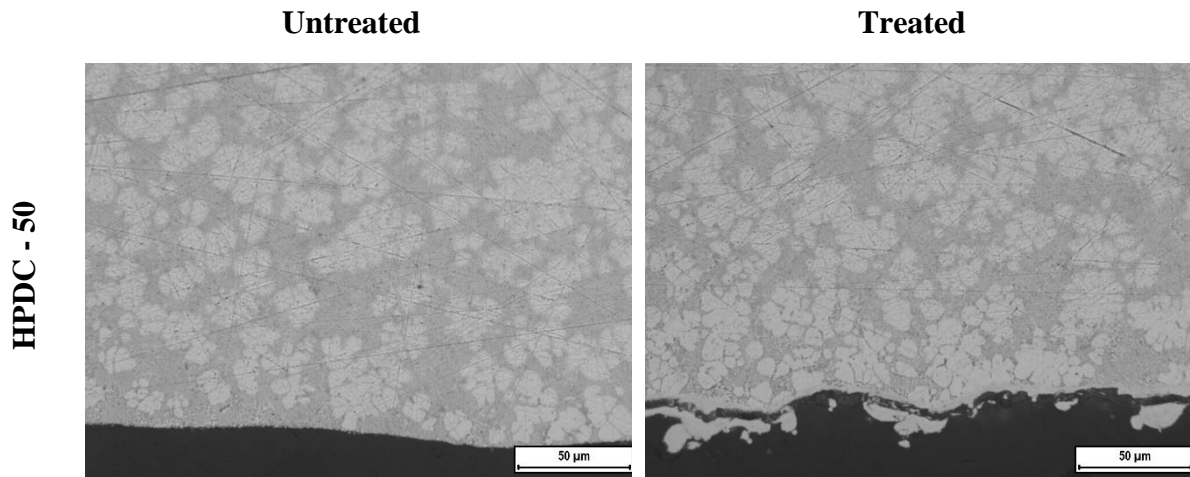
(e)

(f)

Figure 9. Micrographs of, in the left column, sand 98 and, in the right column, sand 200. (a) and (b) show untreated surfaces. (c) – (f) show treated surfaces at two different magnifications.

### 3.1.1 Sand cast samples

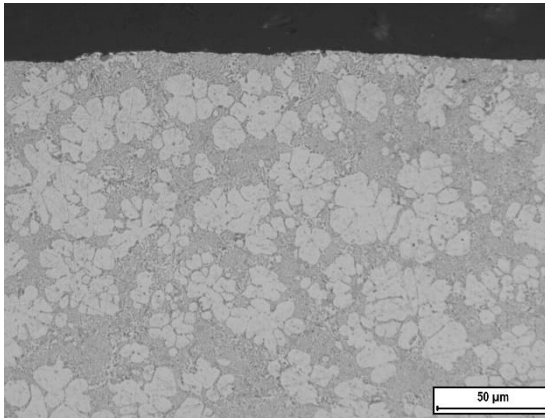
Only small differences related to the appearance of the treated surface could be observed. The laser treated surface was seen to be more jagged than the untreated surface. No significant differences in the microstructure could be observed between the untreated and the treated surfaces. Furthermore, no differences could be observed between the 98kHz and the 200kHz sample.



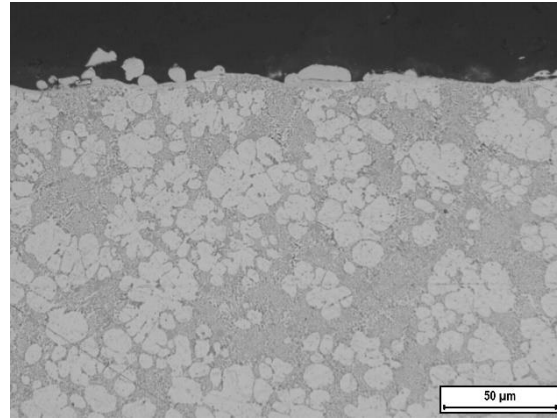
(a)

(b)

HPDC - 98

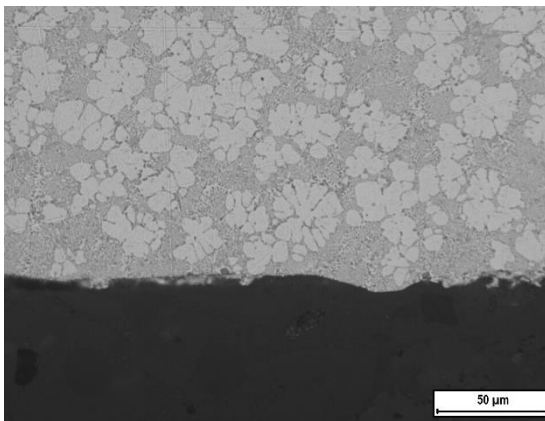


(c)

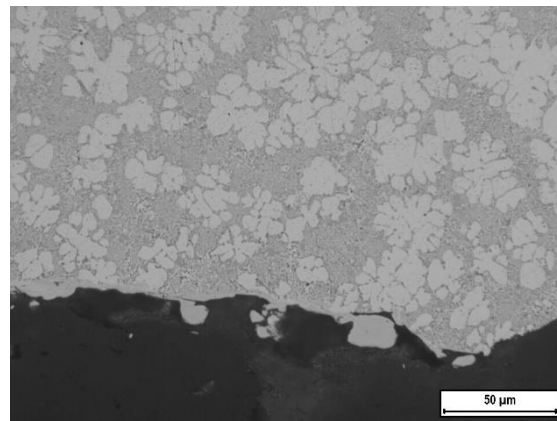


(d)

HPDC - 152



(e)



(f)

HPDC - 200

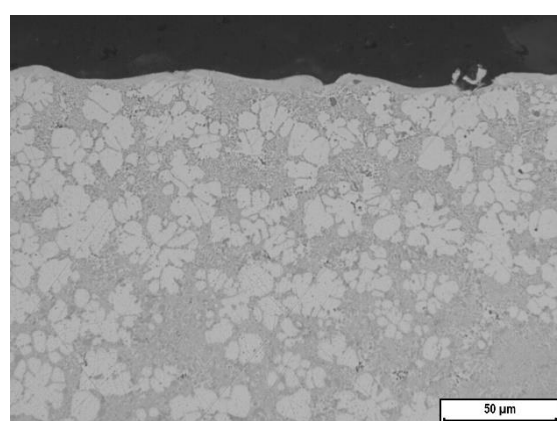
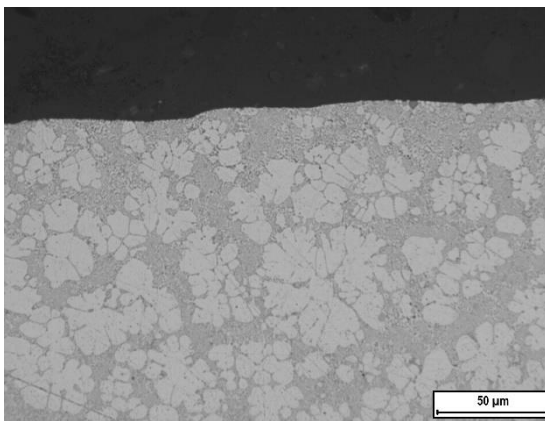
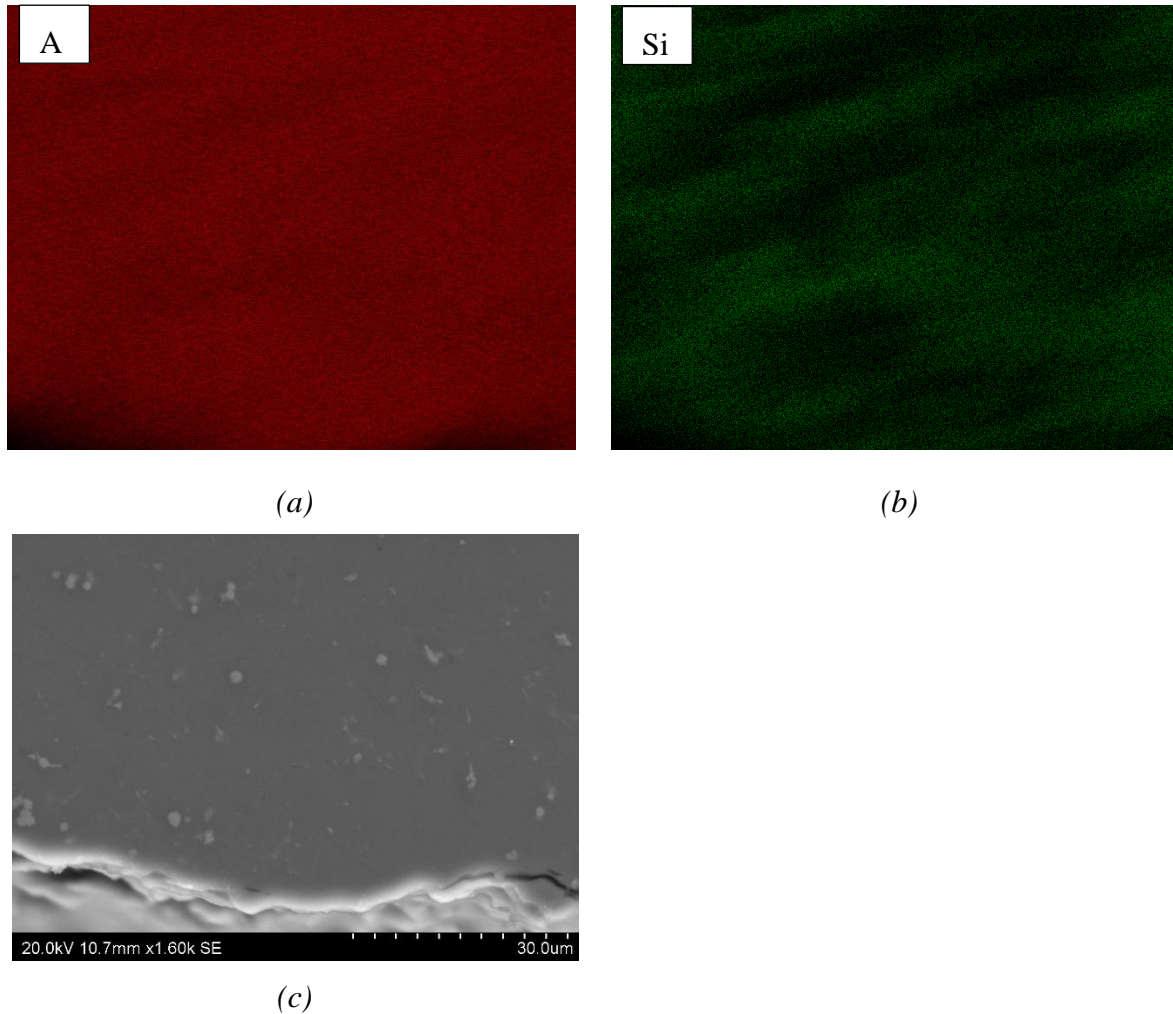


Figure 10. Images of six examined areas. (a) Area 1, (b) Area 2, (c) Area 3, (d) Area 4, (e) Area 5, and (f) Area 6. Original magnification 1000x.

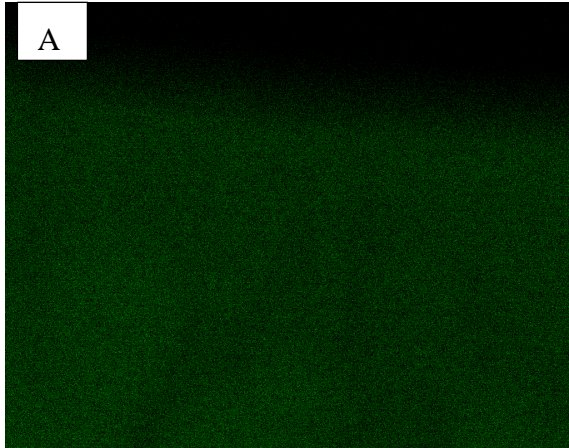
In the HPDC samples differences between the untreated and treated samples were observed. Towards the laser treated surface there is a thin layer where the eutectic silicon is not present. In this layer only aluminium appears to be present, based on the ocular examination. The thickness of this layer varies between about 2-10 µm. The aluminium layer towards the surface is not covering the full length of the examined profile. No significant difference between the four different laser treatments could be observed.

### 3.2 SEM examination

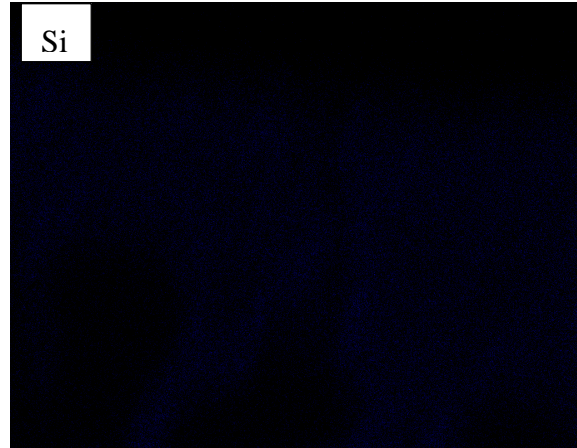
The HPDC sample treated with 50kHz and 98kHz was examined in the SEM. Both sides were analysed. Figure 11 and Figure 12 below show that there were no observations of deviating chemical composition towards the surfaces.



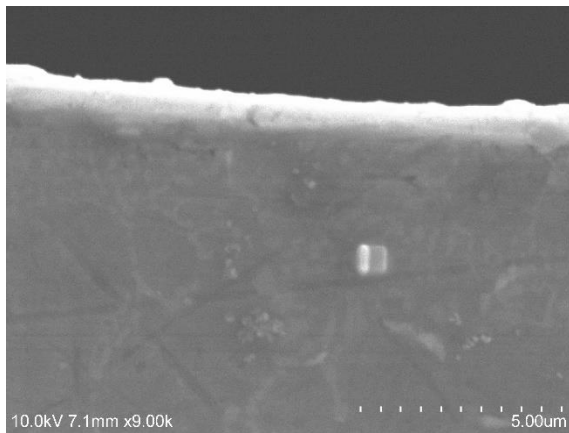
*Figure 11. SEM-EDS examination of the surface treated with 50kHz. (a) The red area shows the distribution of Al. (b) The green colour shows the distribution of Si. (c) secondary electron image of the area analysed.*



(a)



(b)



(c)

*Figure 12. SEM-EDS examination of the surface treated with 98kHz. (a) The green area shows the distribution of Al. (b) The blue colour shows the distribution of Si. (c) secondary electron image of the area analysed.*