CHAPTER FOUR
RESULTS

4.1. Three-point bending test

The mean of flexural strength values for two groups are presented in Table 4.1 and Figure 4.1. The strength values ranged from 469.99 to 1161.04 MPa in the welded specimens. For the control specimens the range was from 1565.29 to 2856.74 MPa. In this study, the mean of flexural for welded specimens (714.39±165.70 MPa) was significantly lower than the mean flexural strength value of control specimens (2211.07±442.64MPa) (Table 4.1).

Table 4.1 Descriptive statistics for flexural strength (MPa).

	N	MPa	SD(±)
specimens	15	714.38	165.73
control	13	2211.07	442.64

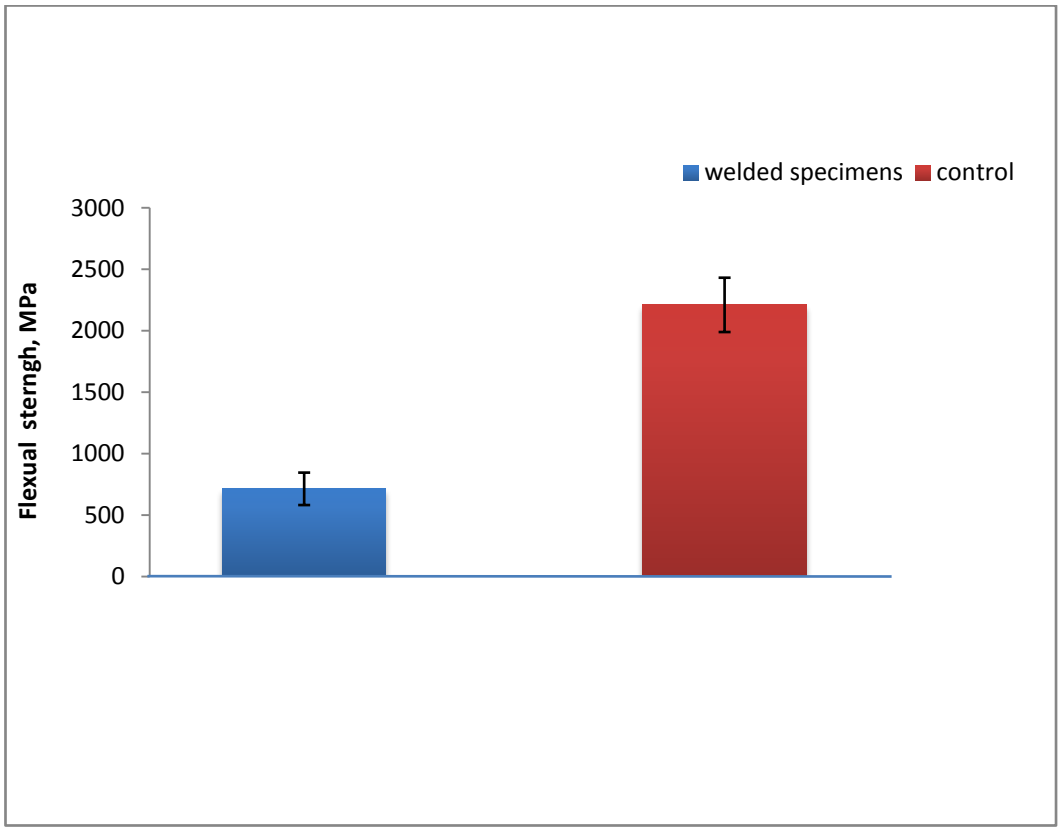

Figure 4.1: Mean flexural strength value for control and welded specimens

4.1.1 Mann-Whitney U for flexural strength

The flexural strength data for laser welded specimens (n = 15) and control specimens (n = 13) was statistically analysed using non parametric Mann-Whitney (U test) at $\alpha = 0.05$ used to test the variance. The results suggested that the flexural strength of the welded specimens were significantly lower than control specimens (Table 4.2).

Table 4.2 The flexural strength value of welded and control specimens in three point bending test

	N	Mean (MPa)	U statistic	P-value
Welded specimens	15	714.38±165.73	0.001	0.000
Control	13	2211.07±442.64		

**Data are statistically significant p≤0.001*

4.2. Tensile strength test

The mean tensile strength value for the two groups is illustrated in Table 4.3 and Figure 4.2. The tensile strength ranged from 209.88MPa to 600.41MPa in the welded specimens. For the control specimens the range was from 704.12 to 900.14MPa. It has been found that the tensile strength value for welded specimens (401.87±124.64MPa) was statistically significantly different from that of control specimens (813.07±50.07 MPa) (Figure 4.2).

Table 4.3 Descriptive statistics for tensile strength value

Materials	N	Mean(MPa)	Std. Deviation
Welded Specimens	15	401.87	145.46
Control	13	813.07	50.07

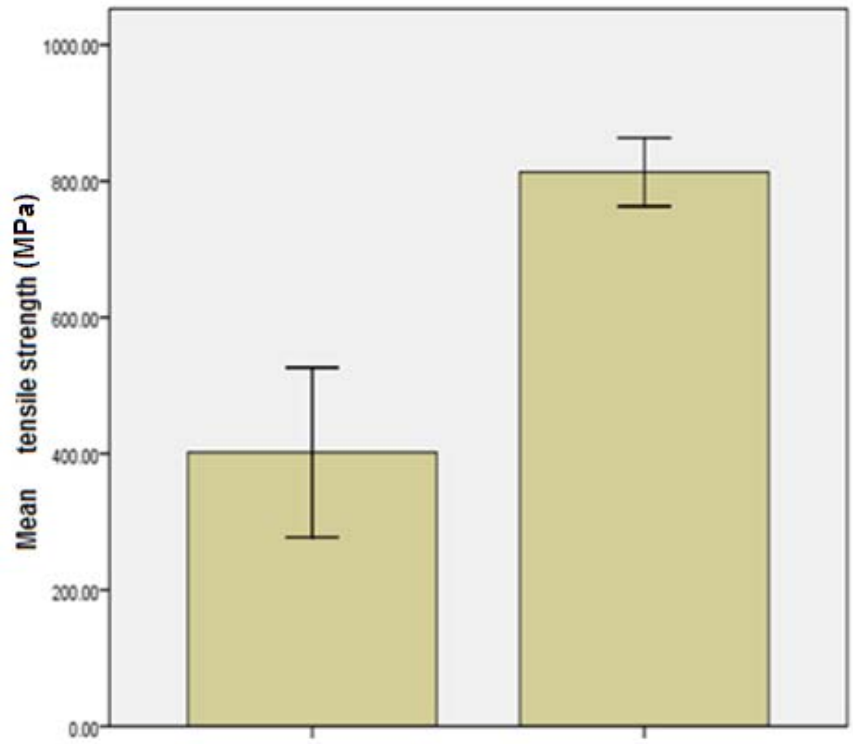

Figure 4.2 Mean tensile strength values and standard deviation of welded and control groups.

Table 4.4 The difference in tensile strength between welded and control specimens.

	N	Mean(MPa)	T statistic	P-value
specimens	15	401.87±124.64	-11.731	0.000
Control	13	813.07±50.07		

**Data statistically significant difference p≤0.001*

4.3 Modulus of elasticity test

4.3.1 Levene's test for equality of variances for modulus of elasticity test

Equal variance is an assumption required to conduct the parametric statistical test. In this respect, the data of the present study was checked using Levene's test for equality of variance. The results of such test revealed that the data of this study is homogenous among data of welded and control group ($p \geq 0.05$) (Table 4.4). Following this t-test was conducted.

Table 4.5 Test of homogeneity of variances

Modulus of elasticity test	Levene Statistic	Sig.
	0.132	0.720

Modulus of elasticity data for welded specimens (n = 15) and control specimens (n = 13) was not statistically significant when analysed using parametric t-test at $\alpha = 0.05$. The results suggested that the modulus of elasticity value of laser welded specimens (5046.42±584.18 MPa) are significantly lower than the value of control specimens (5635.05±583.10 MPa).(Table 4.5).

Table 4.6 The difference in modulus of elasticity between welded and control specimens.

	N	Mean(MPa)	T statistic	P-value
Welded specimens	15	5046.42±584.18	-.704	0.488
Control	13	5635.05±583.10		

**Data are statistically no significant difference*

4.3.2 Descriptive statistics

The mean modulus of elasticity values of the two groups are presented in Table 4.7 and Figure 4.3. The modulus of elasticity ranged from 2288.98MPa to 9203.58MPa in the welded specimens. For the control specimens the range was from 704.12MPa to 900.14MPa. The mean modulus of elasticity value for laser welded specimens (5046.43±2262.52MPa) was lower than the value of control specimens (5635.057±2138.47MPa) (Figure 4.3). This implies that welding of cobalt-chromium and titanium has decreased the modulus of elasticity value.

Table 4.7 Descriptive statistics for modulus of elasticity test

Materials	N	Mean(MPa)	Std. Deviation
Welded Specimens	15	5046.42	3170.22
Control	13	5635.057	2952.17

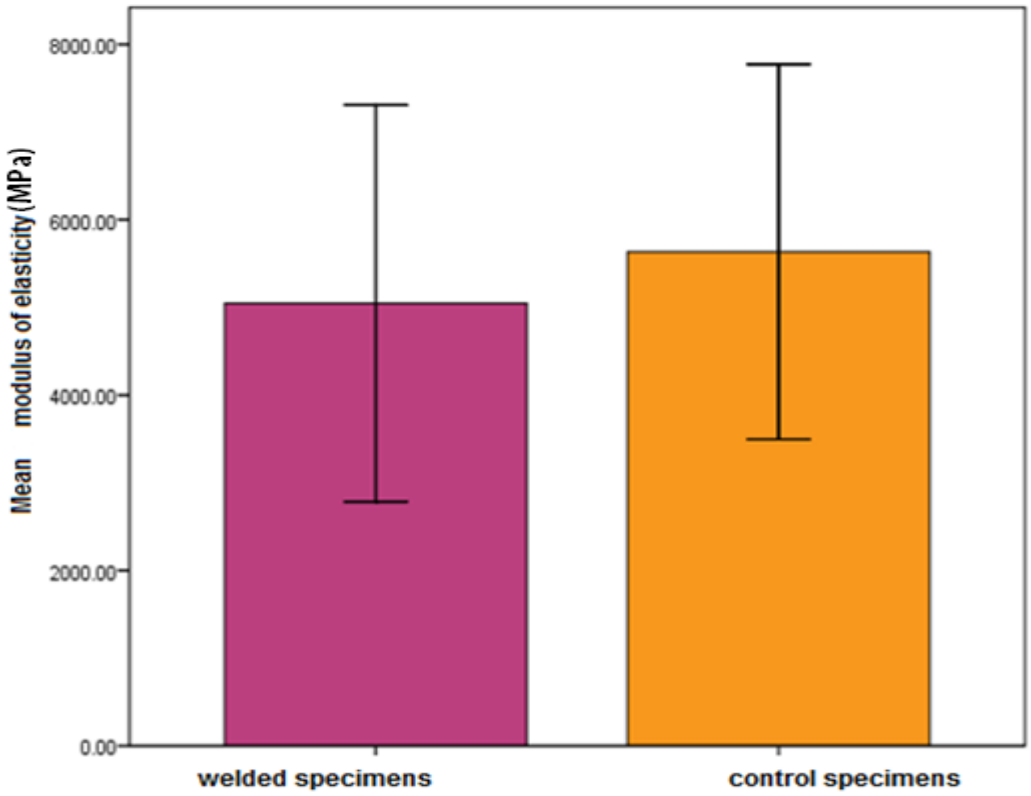

Figure 4.3 Mean modulus of elasticity values and standard deviation of welded and control groups.

4.4 Scanning Electron Microscope

Figure 4.4 represented the surface of cobalt-chromium specimens after fracture. Figures 4.5, 4.6 and 4.7 illustrated the fracture surfaced of the welded joint (Co-Cr and Ti) specimens. There were pores (as indicated by arrows) welded region of the laser-welded specimens.

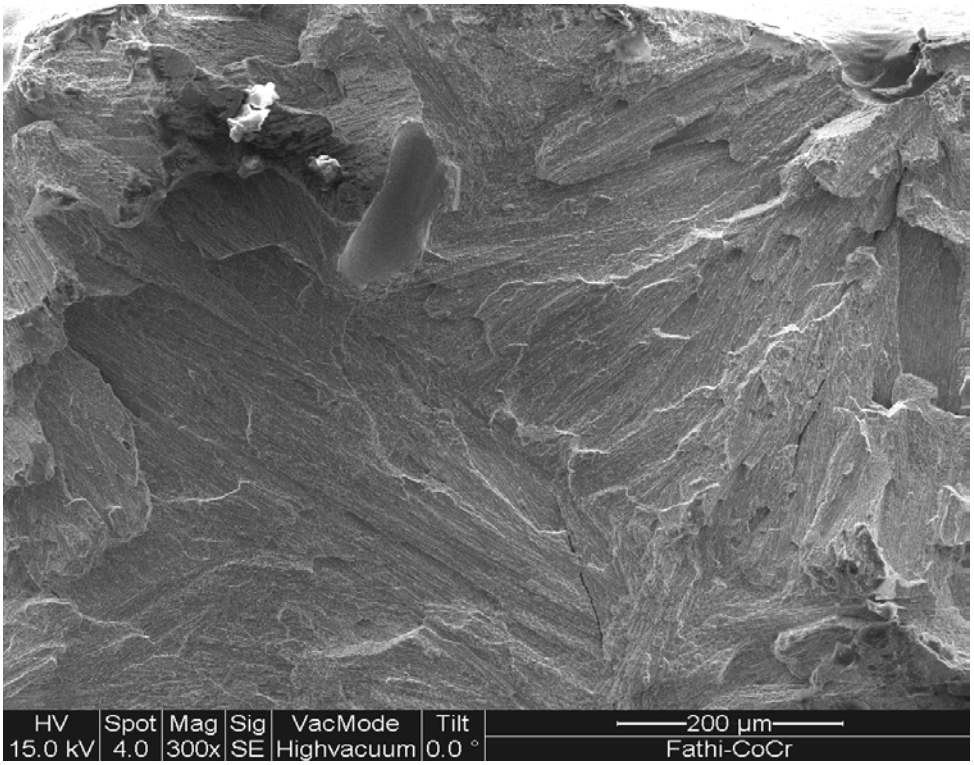

Figure 4.4 SE Micrograph microstructures of control cobalt-chromiumafter tensile test (Magnification: 300 X)

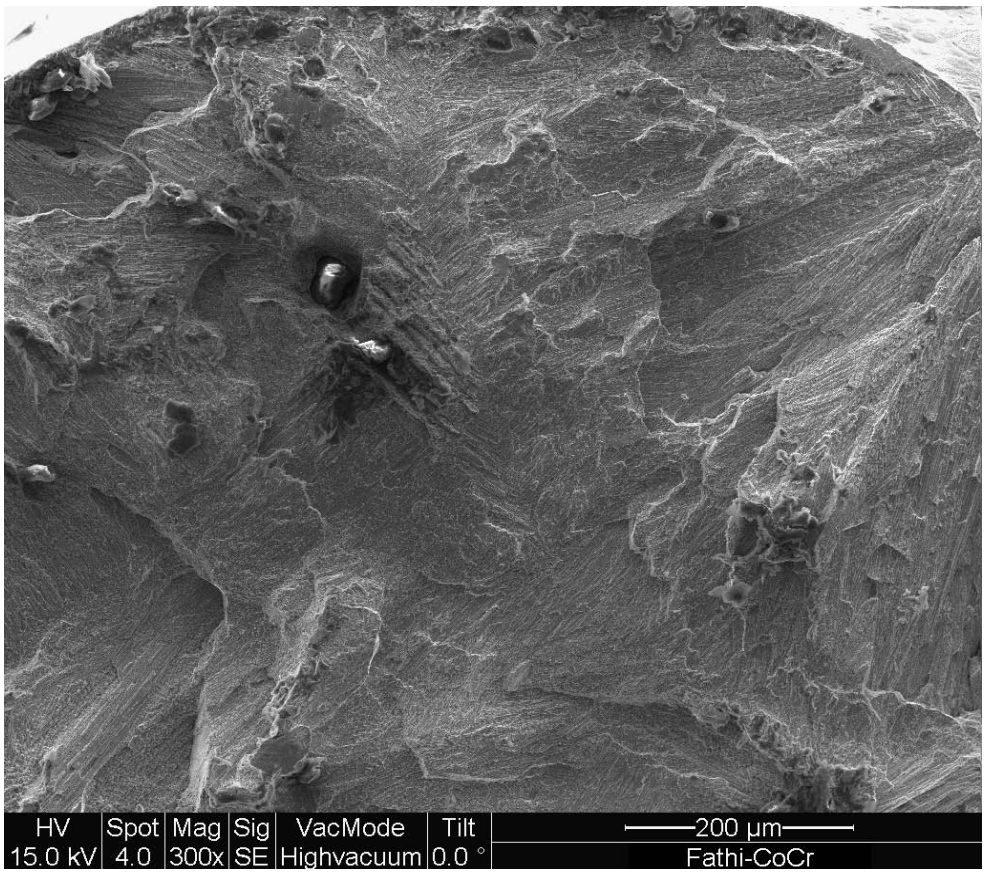

Figure 4.5 SE Micrograph microstructures of welded joint of cobalt-chromiumafter tensile test (Magnification: 300 X).

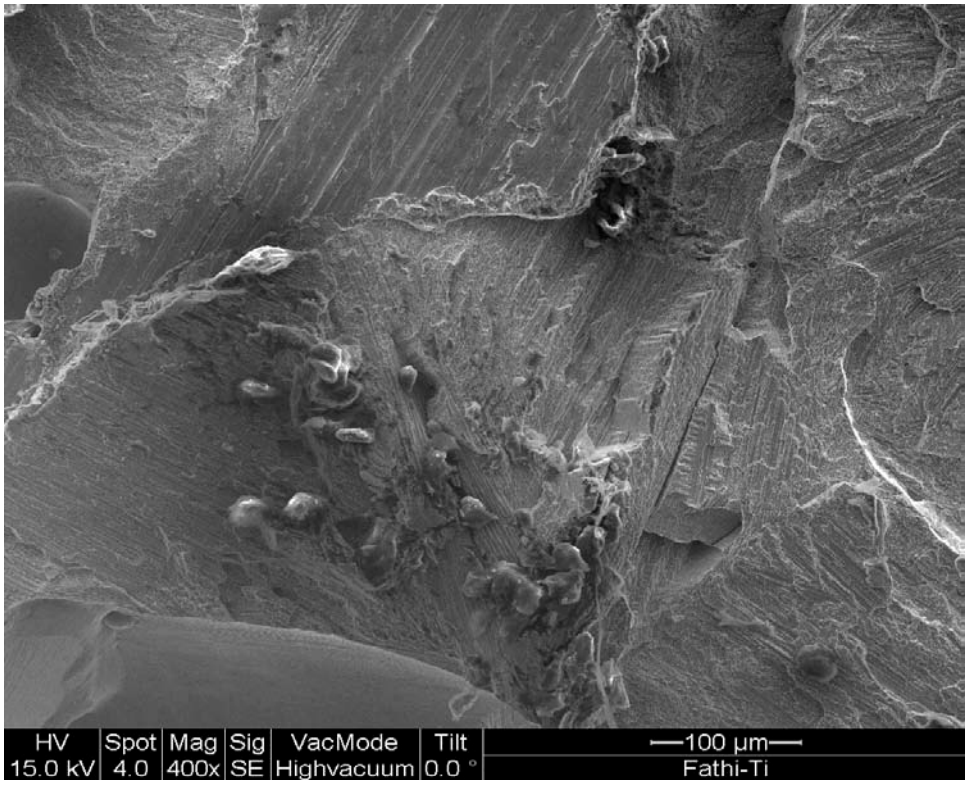

Figure 4.6 SE Micrograph microstructures of welded joint of titanium after tensile test (Magnification: 400 X).

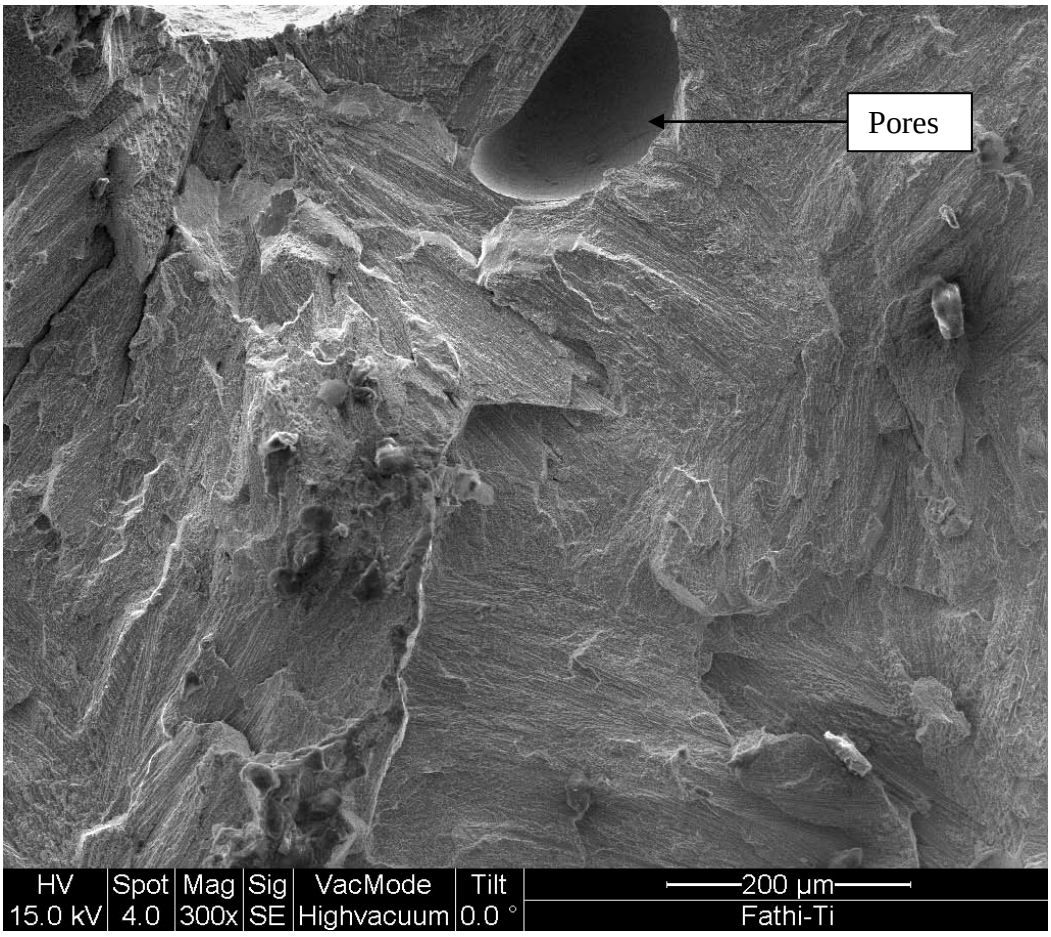

Figure 4.7 SE Micrograph microstructures of welded joint of titanium after tensile test (Magnification: 300 X).