Conclusion

9.1 Conclusion

The following conclusions are made from the work of the present thesis.

1. The experimental values of low cycle fatigue parameters viz. cyclic strain exponent and cyclic strength coefficient are in good agreement with that obtained by theoretical method.
2. The elastic and plastic strain on the surface of the specimen along the cross section of failure obtained by finite element analysis are in good agreement with the experimental values for all cases.
3. Yield stress decreases with increasing heat treatment temperature at constant soaking time and with increasing soaking time at constant heat treatment temperature but increases with increasing volume fraction of reinforcement particle in MMC as shown in Fig. 9.1.
4. Maximum engineering stress for monotonic tensile test decreases with increasing heat treatment temperature at constant soaking time but remains almost constant with increasing soaking time at constant heat treatment temperature and with increasing volume fraction of reinforcement particle in MMC as shown in Fig. 9.2.
5. Modulus of elasticity or Young's modulus remains almost constant with increasing heat treatment temperature at constant soaking time and with increasing soaking time at constant heat treatment temperature and with increasing volume fraction of reinforcement particle in MMC as shown in Fig.9.3.

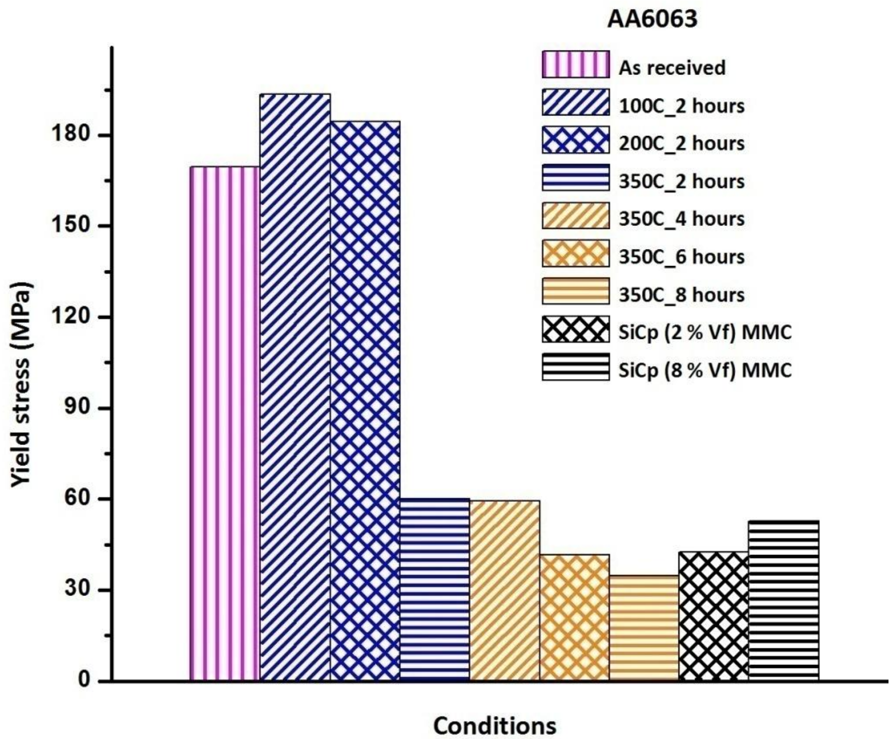

Fig. 9.1 Variation of yield stress with different conditions

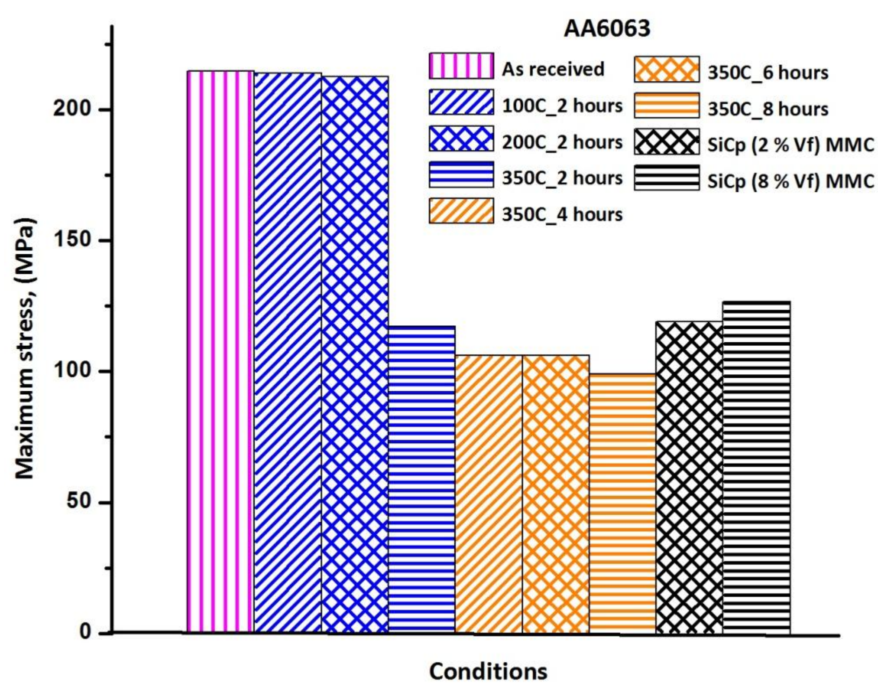

Fig. 9.2 Variation of maximum stress with different conditions

6. Modulus of rigidity or shear modulus decreases with increasing heat treatment temperature at constant soaking time and with increasing soaking time at constant heat treatment temperature and with increasing volume fraction of reinforcement particle in MMC as shown in Fig. 9.4.
7. Strain hardening exponent (n) increases with increase heat treatment temperature at constant soaking time and with soaking time at constant heat treatment temperature but decreases with volume fraction of reinforcement particle in MMC as shown in Fig. 9.5.

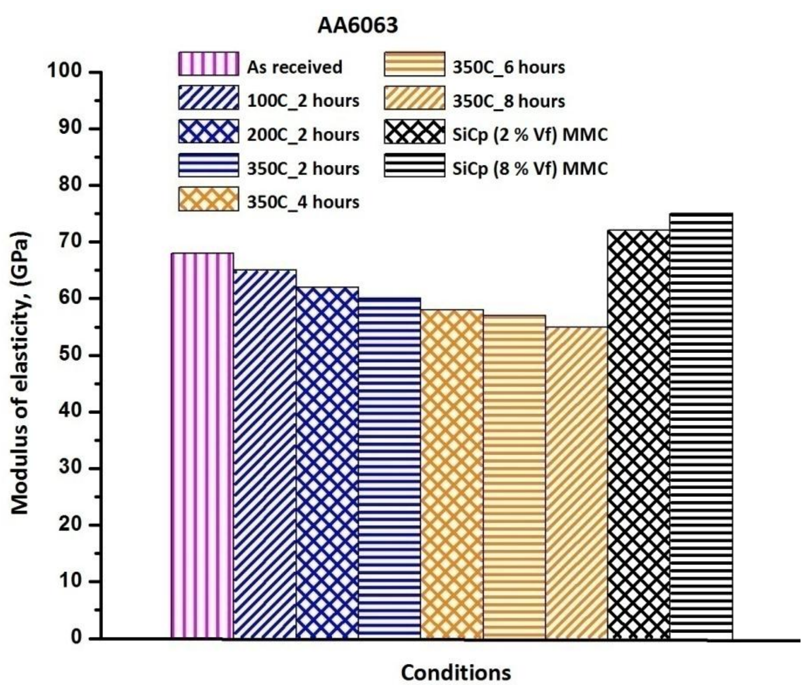

Fig 9.3 Variation of modulus of elasticity with different conditions

8. Strength coefficient remains almost constant with heat treatment temperature at constant soaking time but increases with soaking time at constant heat treatment temperature and decreases with volume fraction of reinforcement particle in MMC as shown in Fig. 9.6.

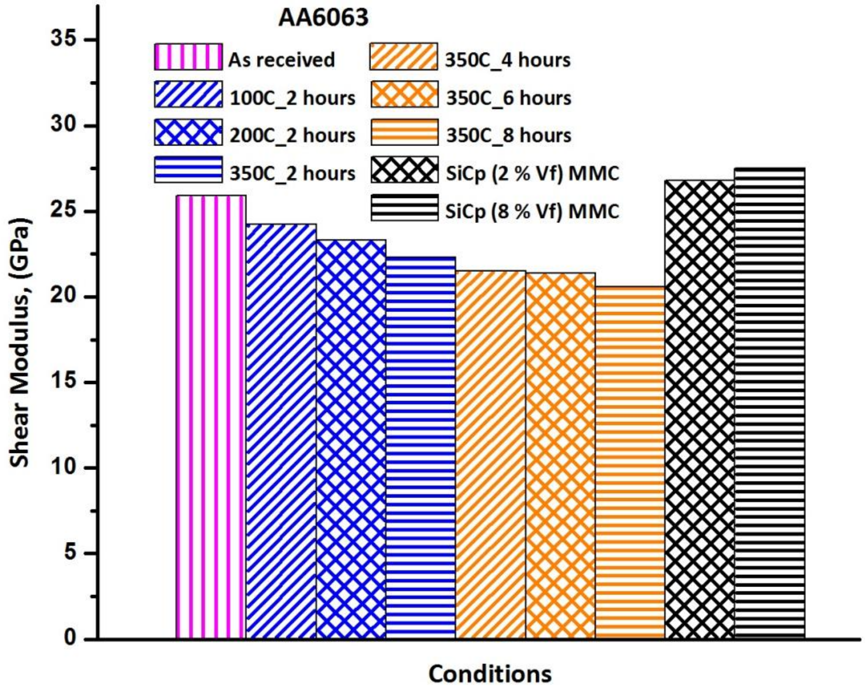

Fig 9.4 Variation of Modulus of rigidity with different conditions

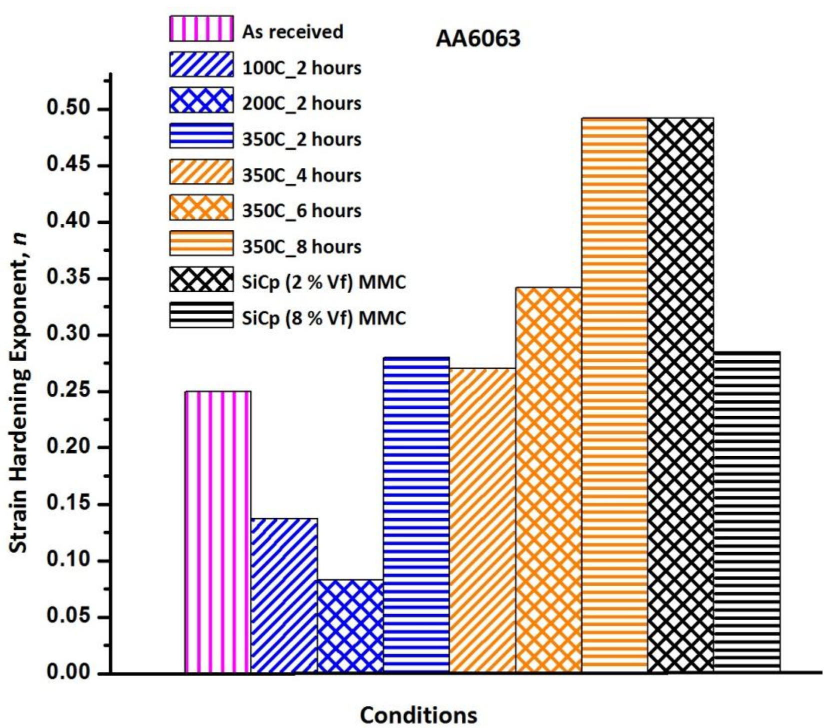

Fig. 9.5 Strain hardening exponent at various conditions

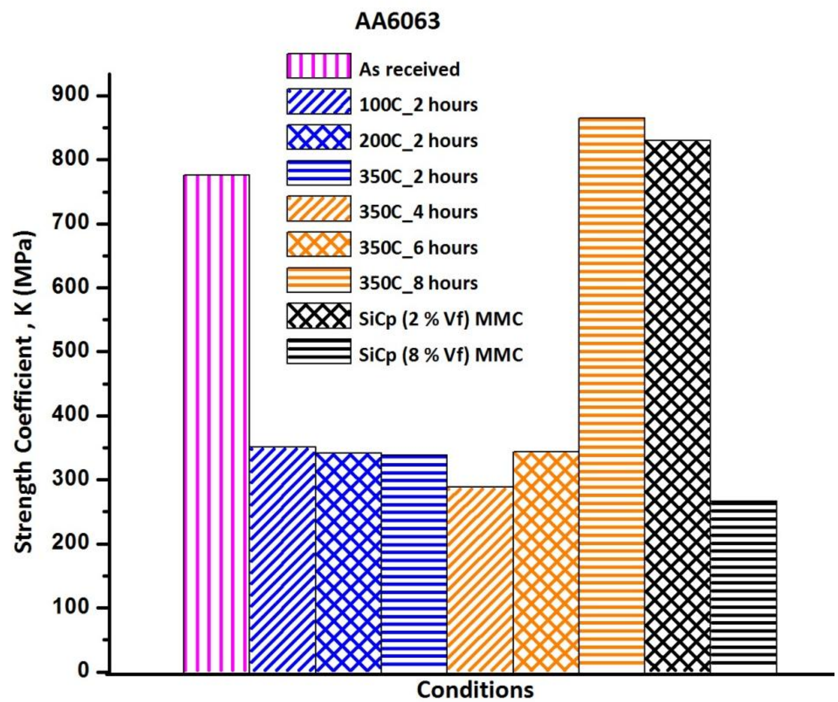

Fig. 9.6 Strength coefficient at various conditions

9. Transition fatigue life increases considerably with the increase in heat treatment temperature for constant soaking time and with the increase in volume fraction of reinforcement particle in MMC while it initially increases considerably with the increase in soaking time of heat treatment at constant temperature but after certain time decreases considerably as shown in Fig. 9.7.
10. Fatigue ductility exponent has initially increasing tendency with the increase in heat treatment temperature for constant soaking time as well as with soaking time of heat treatment at constant temperature but with further increase in temperature or time it reduces whereas increases with increase in volume fraction of reinforcement particle in MMC as shown in Fig. 9.8.
11. Fatigue ductility coefficient or cyclic plastic strain behavior is same to that of fatigue ductility exponent for heat treatment temperature and volume fraction of

MMC variation, but it has a decreasing tendency with increase of soaking time at constant heat treatment temperature as shown in Fig. 9.9.

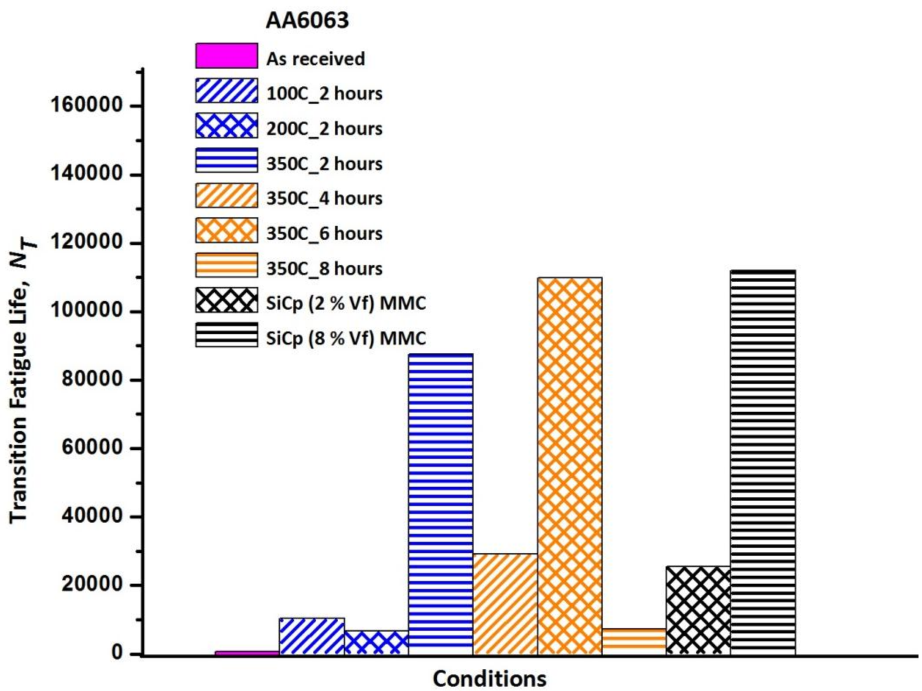

Fig. 9.7 Transition fatigue life at various conditions

12. Fatigue strength exponent have decreasing tendency with the increase in heat treatment temperature for constant soaking time but have increasing tendency with soaking time of heat treatment at constant temperature whereas it remains almost constant with volume fraction of reinforcement particle in MMC as shown in Fig. 9.10.
13. Cyclic strength coefficient has initially decreasing tendency with increase in heat treatment temperature at constant soaking time and with increase in soaking time at constant heat treatment temperature, but afterwards it increases whereas it has decreasing tendency with increase in volume fraction of MMC as shown in Fig. 9.11.

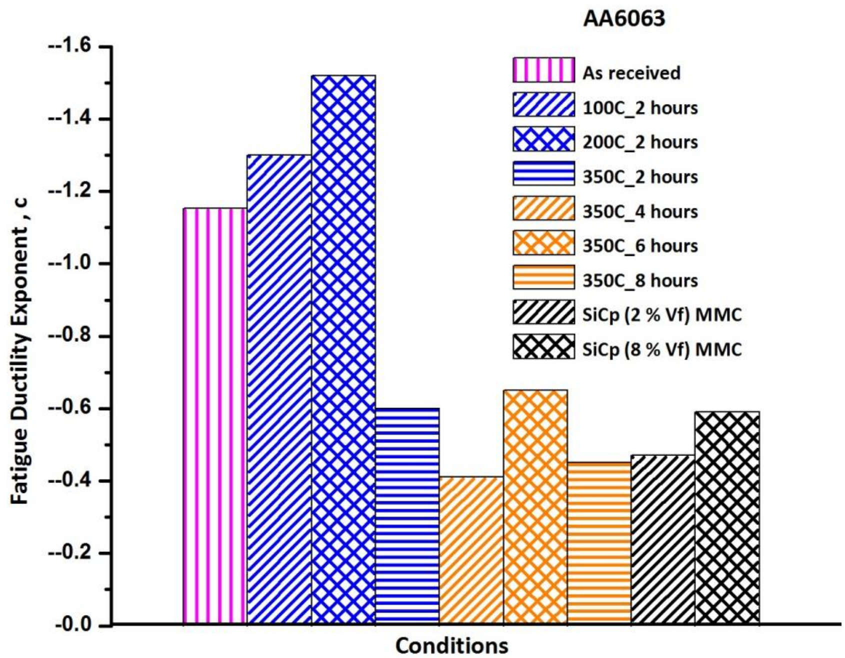

Fig. 9.8 Fatigue ductility exponent at various conditions

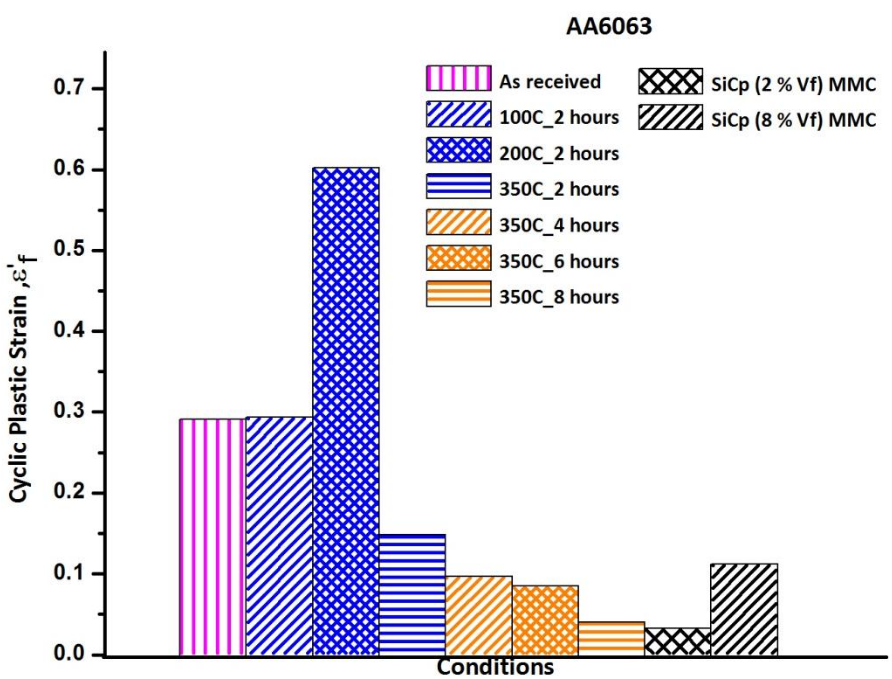

Fig. 9.9 Fatigue ductility coefficient at various conditions

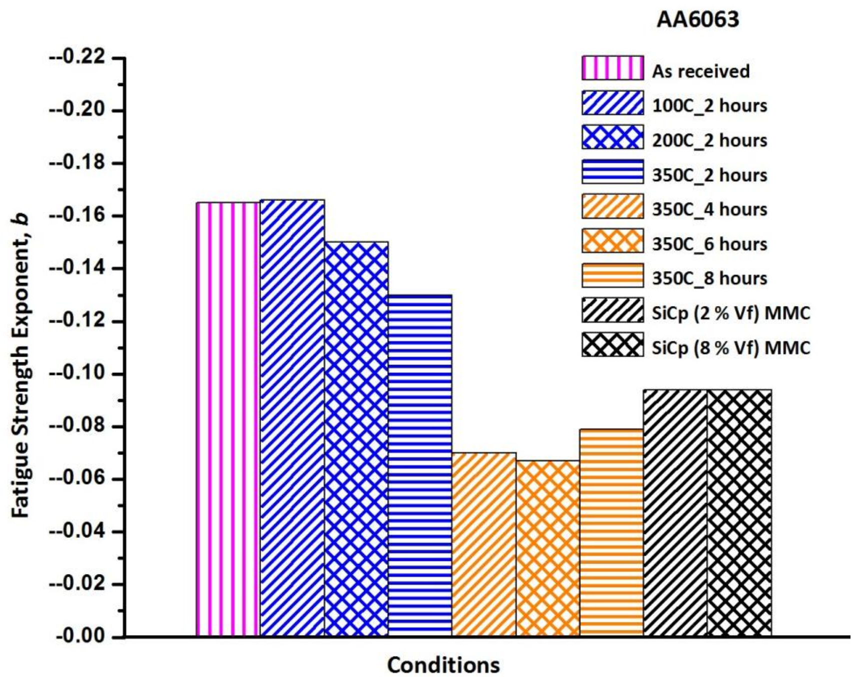

Fig. 9.10 Fatigue strength exponent at various conditions

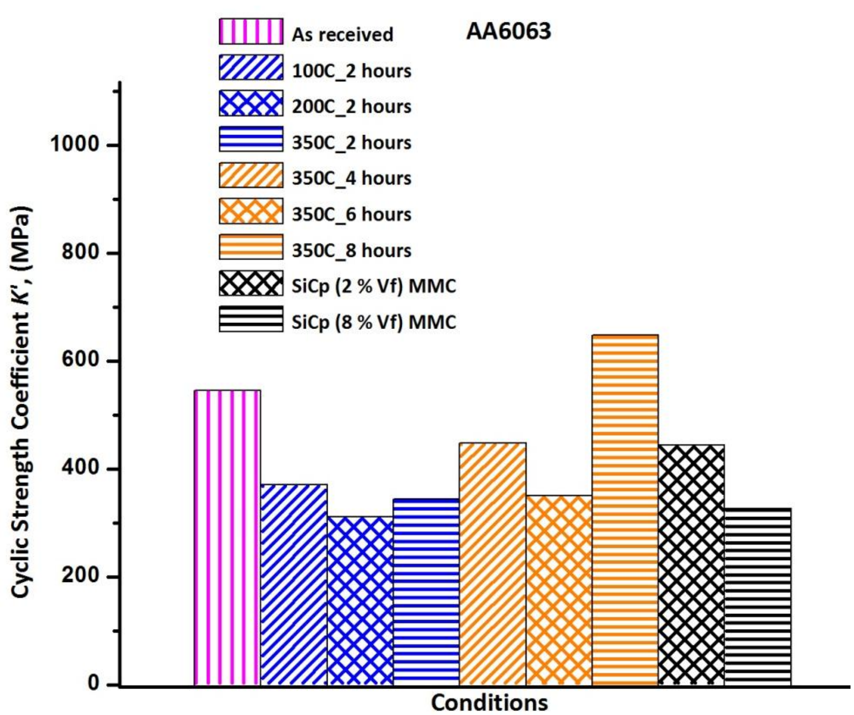

Fig. 9.11 Cyclic strength coefficient at various conditions

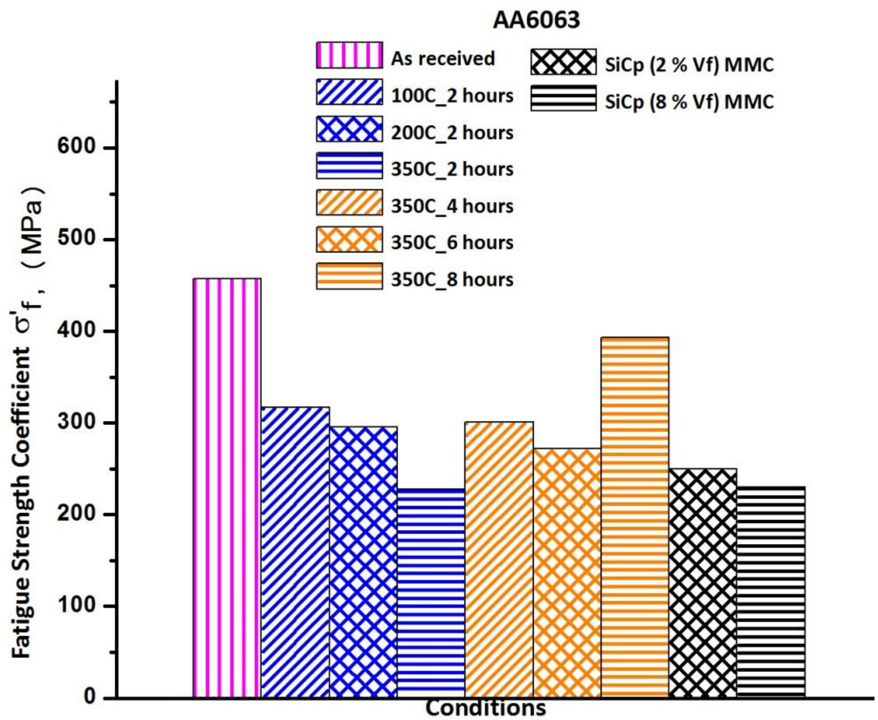

Fig. 9.12 Fatigue strength coefficient at various conditions

14. Fatigue strength coefficient has decreasing tendency with the increase in heat treatment temperature for constant soaking time but initially decreases with soaking time of heat treatment at constant temperature but after certain time increases whereas initially decreases with volume fraction of reinforcement particle in MMC as shown in Fig. 9.12.
15. Cyclic strain hardening exponent has initially decreasing tendency with increase in heat treatment temperature for constant soaking time and soaking time of heat treatment at constant temperature but afterwards increases whereas decreases with increase in volume fraction of reinforcement particle in MMC as shown in Fig. 9.13.
16. The energy dissipation per cycle of loading for low cycle fatigue analysis using simply support specimen increases with increase in strain amplitude Fig. 9.14.

17. Out of six cases of strain amplitude two cases show strain hardening behavior which is evident from the fact of increase of stress with number of cycles. This observation is in contrary to the criteria of softening behavior of $\sigma_{UTS}/\sigma_{YS} < 1.2$. This implies that cyclic softening or hardening behavior during low cycle fatigue analysis using simply support specimen is strongly related to strain amplitude applied during the experiment.

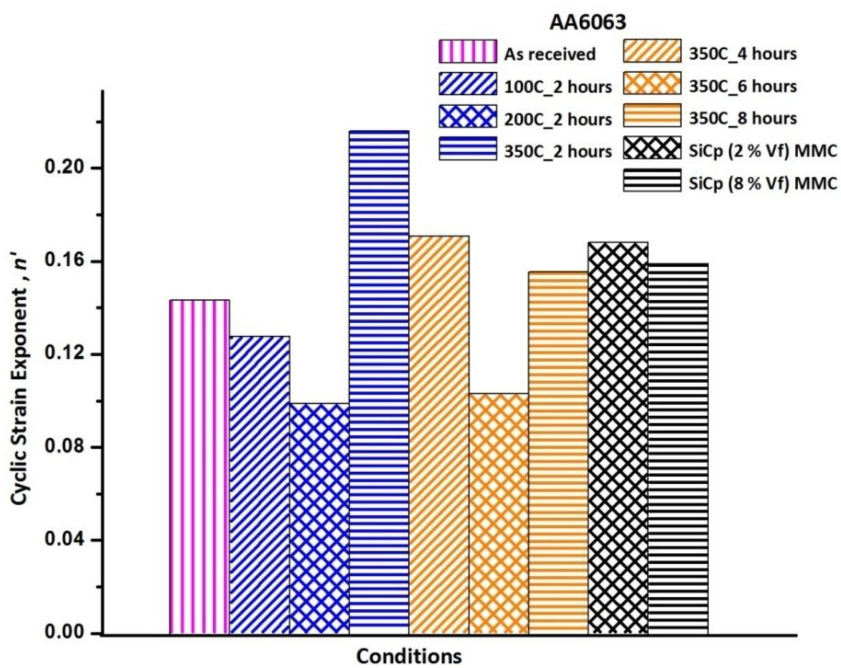

Fig. 9.13 Cyclic strain exponent at various conditions

18. Crystallite size initially increases with increase in heat treatment temperature at constant soaking time but decreases after certain temperature and with increase in volume fraction of reinforcement particle in MMC while it has decreasing tendency with increase in soaking time at constant heat treatment temperature.
19. Observations of SEM pictures of fracture surfaces show low cycle fatigue features like crack initiation, ratchet marks, fatigue striations, fatigue cleavages, beach marks, progression marks and overload zones.

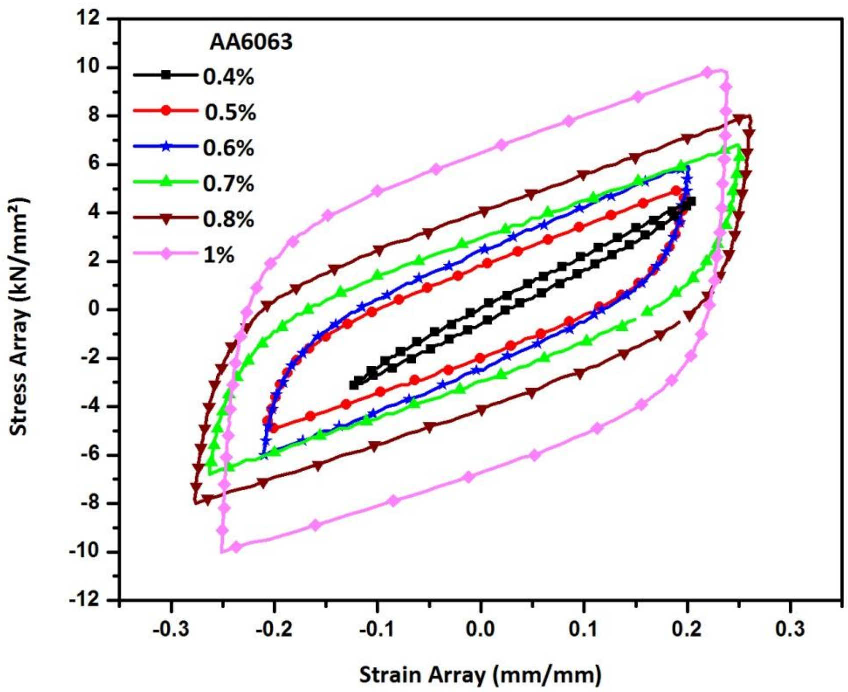

Fig. 9.14 Cyclic hysteresis loop stress-strain curves plotted at different cycles numbers at different strain amplitude and 2*10-3 strain rate

9.2 Future scope

Following are the future research directions possible

1. Investigation on the Low cycle fatigue performance of aluminum Metal Matrix Composite with different types of nano particle reinforcements having different volume fractions.
2. Investigation on the Low cycle fatigue performance of aluminum Metal Matrix Composite using micromechanics approach and finite element analysis.
3. Investigation on the Low cycle fatigue performance of aluminum Metal Matrix Composite with different types of micro and nano particle reinforcements having different volume fractions at different heat treatment temperatures and different soaking times.

4. Investigation on the effect of natural and artificial aging on the Low cycle fatigue performance of aluminum alloy and its Metal Matrix Composite with different types of micro and nano particle reinforcements having different volume fractions at different heat treatment temperatures and different soaking times.
5. Investigation on the effect of different conditions viz. sea water, chemical environment, radiation environment and outer space environment on the Low cycle fatigue performance of aluminum alloy and its Metal Matrix Composite with different types of micro and nano particle reinforcements having different volume fractions at different heat treatment temperatures and different soaking times.