UNIVERSITI TEKNOLOGI MARA

MICROSTRUCTURAL AND WEAR PROPERTIES OF Fe-BASED HARDFACING MATERIALS DEPOSITED ON CARBON STEEL BASE METAL

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Thesis submitted in fulfilment
of the requirements for the degree of
Doctor of Philosophy
(Science)

Faculty of Applied Sciences

July 2018

ABSTRACT

The study focused on microstructural investigation and wear analysis of iron (Fe) based hardfacing fillers of Series 1 (hypereutectic white cast iron (WCI)) – alloys A, B, C and D; Series 2 (hypoeutectic WCI) – alloys F, G and H; and Series 3 (hypereutectoid steel) – alloy E. The hardfacing alloys were deposited on carbon steel base metal using self-shielded flux cored arc welding (FCAW) technique onto the base metal which is SJR235RG2 type steel. Phase formation, microstructural and mechanical properties of hardface deposits were investigated in the as-deposited condition. In Series 1, the addition of niobium (Nb) and molybdenum (Mo) with tungsten (W) and vanadium (V) additives resulted in microstructure refinement of the proeutectic M_7C_3 carbide phase as revealed by optical microscopy and field-emission scanning electron microscope (FESEM) analysis. XRD (x-ray diffraction) and energy dispersive x-ray (EDX) analysis showed the existence of M_7C_3 (M=Cr, Fe), MC (M=Nb, Mo) and the matrix of α-ferrite phase. Nb and Mo found to form MC carbide while W and V dispersed uniformly in matrix and carbide phase. The increasing of alloying elements in the filler further increased the microstructure refinement, increased hardness and wear resistance. The main wear mechanism observed in Series 1 hardfacing alloys are abrasive wear, indicated by surface grooves and surface fatigue, indicated by material delamination. In Series 2, the major addition of titanium (Ti) with Mo, Nb and V, resulted in fine distribution of MC carbides embedded within α-dendritic structure as revealed by optical microscopy and FESEM analysis. XRD and EDX analysis showed the existence of M_7C_3 (M=Cr, Fe), MC (M=Ti, V, Nb, Mo) and the matrix of α-ferrite phase. Increase of hardness and wear resistance is due to the distribution of MC carbide and excess chromium (Cr) that dissolves in the α-ferrite phase as solid solution. The main wear mechanism observed in Series 2 hardfacing alloys is abrasive wear, while hardface alloys with alloying addition showed surface delamination which was attributed to the presence of soft phase adjacent to the MC carbides. In Series 3, optical microscopy and FESEM-EDX analysis showed existence of MC (M=Ti, V, Mo), martensite and retained austenite. The dilution effect has resulted in the formation of martensite and retained austenite matrix. Thus, the strength of hardface deposit was contributed from MC carbide dispersion, martensite phase and the Cr solid solution that dissolved in the matrix.

ACKNOWLEDGEMENT

Alhamdulillah, The Most Gracious, The Most Merciful, peace and blessing of Allah upon His Beloved Muhammad, for giving me the opportunity to commence on my study as well for the strength, energy and wellbeing to complete it.

Firstly, I would like to express my deepest gratitude to my honourable supervisor, Dr. Mahesh Kumar Talari who had tirelessly guided me while pursuing this study, for his best guidance, patience, motivation, immense knowledge and continuous support. He has provided me with his constructive views and full professionalism without which this study not be completed. His guidance helped me in all the time of this thesis completion as well as in other research papers. I could not have imagined having a better advisor and mentor for this study. Besides, my appreciation goes to my respectable co-supervisors, Dr. Venugopal Thota and Prof. Dr. Mohamad Kamal Harun. Without their precious support it would not be possible to conduct this research.

I place on record, my sincere thank you to my fellow comrades, Dr. Ahmad Lutfi Anis and Widyani Darham, as well as Izzul Adli Mohd Arif, for all their help and guides, the sleepless nights we were working together before deadlines, and for all the fun we have had in our memorable “home” - B433. Not to forget, thank you to Mr. Azlan Zakaria and Dr. Mohd Husairi Fadzilah Suhaimi for their contributions in the B433’s circle. I am also grateful to other postgraduate colleagues, laboratory assistants and any individual involved directly or indirectly throughout all the time of this study.

In particular, I wish to express my special thanks from the bottom of my heart to my family for their great understanding, patience, abundance of love and great deal of encouragement morally, spiritually and materially in this long and challenging journey. I also would like to thanks to Wan Mimi Suziana Wan Omran for her advices, moral support and understanding during crucial moment in my study. I also would like to thanks to all my friends, especially to my fellow runners and hikers for their good wishes

.

Finally, this thesis is dedicated to my late brother, Azman Jilleh, for his enormous influence in my life.

Thank you.

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