

CONSTITUTION OF THE Pt-Cr-Nb SYSTEM

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A dissertation submitted to the Faculty of Engineering and the Built Environment, University of the Witwatersrand, in fulfilment of the requirements for the degree of Master of Science in Engineering (Metallurgy and Materials Engineering).

JOHANNESBURG, DECEMBER 2008.

DECLARATION

I, Fulufhelo Marandela Lloyd Mulaudzi, declare that this dissertation is my own unaided work, except where otherwise acknowledged. It is being submitted for the degree of Master of Science in Engineering (Metallurgy and Materials Engineering) at the University of the Witwatersrand, Johannesburg, South Africa. It has not been submitted previously at this, or any other university for any degree or examination.

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_____ day of December 2008

ABSTRACT

Superalloys based on platinum-group metals (PGMs) are being developed for high temperature applications. Currently, the optimum alloy is Pt₈₄:Al₁₁:Ru₂:Cr₃, and work is ongoing. Niobium is a possible addition to increase the melting point, but limited phase diagram data are available. Although work has been done on the Pt-Al-Nb system, there are no reported data for Pt-Cr-Nb.

This is a study of the Pt-Cr-Nb system. As-cast samples of the Pt-Cr-Nb ternary system were investigated using scanning electron microscopy with energy-dispersive X-ray spectroscopy, and X-ray diffraction. The results were used to plot a solidification projection and all binary phases extended into the ternary, except for α Pt, which was not identified in this investigation. The extensions of the binary phases were: (Cr) ~2 at.% Nb; (Pt) ~24 at.% Nb and 65 at.% Cr; (Nb): ~12 at.% Pt and ~17 at.% Cr; \sim NbPt₂: ~20 at.% Cr; \sim NbCr₂: ~18 at.% Pt; \sim Cr₃Pt: ~10 at.% Nb; \sim β NbPt₃: ~4 at.% Cr and \sim Nb_{1-x}Pt_{1+x}: ~13 at.% Cr. Five ternary phases were identified: τ 1:~Nb₁₇:Cr₆₄:Pt₁₉; τ 2:~Nb₂₈:Cr₅₅:Pt₁₇; τ 3:~Nb₃₀:Cr₃₀:Pt₄₀; τ 4:~Nb₄₅:Cr₂₇:Pt₂₈ and τ 5:~Nb₄₀:Cr₁₈:Pt₄₂. The liquidus surface was derived using the binary phase diagrams, identified primary phases, solidification sequences and the solidification projection, together with the eutectic compositions. Nineteen ternary invariant reactions were identified.

Hardness measurements were made on all samples, and also toughness and fracture toughness were deduced. Alloys with (Pt) and \sim NbPt₂ were ductile with reasonable hardness. Alloys containing (Cr), (Nb), \sim Cr₃Pt, \sim NbCr₂, \sim Nb₃Pt and \sim Nb₂Pt were extremely brittle with cracks, whereas alloys containing \sim β NbPt₃ and \sim Nb_{1-x}Pt_{1+x} phases were slightly brittle.

This dissertation is dedicated to my parents:

Nditsheni and Annemarie Mulaudzi

ACKNOWLEDGEMENTS

I would like to express my thanks to the following people and organisations for their contribution to this work and for also making this exciting work possible.

- The spiritual guidance of the God of Engenas, Edward and Barnabas Lekganyane.
- My supervisors, Profs. L.A. Cornish and M.J. Witcomb for their support and guidance, and most especially Prof L.A. Cornish for her invaluable assistance in interpreting all the results. I really owe you one!
- The financial assistance of MINTEK (Council of Minerals Technology) and DST/NRF Centre of Excellence in Strong Materials is gratefully acknowledged.
- The Platinum Development Initiative (PDI) for the material used in this investigation.
- Prof. M.J. Witcomb and Mr Edson Muhuma for sectioning the samples.
- Retha Rossouw for scanning electron microscope with energy-dispersive X-ray spectroscopy analysis from NMISA.
- To the following people, from Advanced Materials Division at Mintek: Wendy Tshwane, Rainer Süß and Lizelle Glaner for their assistance.
- My Family and friends, for their love and support throughout the years, by helping me in many, treasured ways.
- Final thanks to my love Mokgobo “AKA” (Mpho), for her interest, understanding, support and love.

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