University of Technology, Sydney

Faculty of Science

A STUDY OF THIN-FOIL ROLLING AND THE DEVELOPMENT OF AN Al-Fe-Mn-Si LIGHT GAUGE FOIL ALLOY

Part 1

Course: N054 Doctorate in Science – (by Thesis)

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CERTIFICATE OF AUTHORSHIP/ORIGINALITY

I certify that the work presented in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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ABSTRACT

There has been a trend in recent years to produce thinner but stronger thin-foil aluminium alloys at higher production velocities. This thesis discusses and examines product quality, rolling parameters, thermal treatment, web handling and alloy development in the context of the production of thin-foil aluminium products. The information is to be included in the ALCOA metallurgical database

Web failures are categorised and investigated over the life of the project. A short definition is provided followed by remedies to reduce or avoid re-occurrences. The effect of boundary lubrication between the metal and roll surfaces on web failure is summarized by the Mansell curve. The Mansell curve expresses rolling lubrication as a function of film strength and film thickness, and will be useful in determining rolling lubricant composition and temperature.

Optimal settings based on current rolling practices are determined for unwind tension/stress, lubricant viscosity, load and rewind tension/stress to achieve a consistent desired mill speed. The parameters are determined using existing rolling theory and are essential in maintaining production volume with decreasing gauge.

The improved stability of the process provides the foundation for trials on a new unique high strength alloy, AA8150 and accompanying process, developed and registered by the author. Alloy 8150 utilises a unique combination of high cold reduction, solid solution strengthening, constituent and dispersion strengthening to produce a fine grained structure with high strength and formability characteristics.

The wrought aluminium alloy 8150 contains iron, manganese and silicon at greater than 20% from the eutectic composition. High cold reduction with no intermediate thermal treatment results in highly misorientated random alignments in the deformation zone that surround large constituent particles, $Al_{12}(FeMn)_3Si$ and $(FeMn)Al_6$, making them effective recrystallisation nuclei sites. The $Al_{12}(FeMn)_3Si$ and $Al_{12}(MnFe)_3Si$ dispersoids/precipitates that occur during thermo-mechanical processing reduce the energy of the high angle boundaries, 'pinning' the boundary causing a new boundary to be formed as it curves around the particle, enhancing the nucleation of recrystallisation sites.