UNIVERSITI TEKNOLOGI MARA

NUMERICAL MODELING OF LAYER GROWTH RESULTING FROM LOW TEMPERATURE HYBRID THERMOCHEMICAL TREATMENT IN AISI 316L STAINLESS STEEL

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ABSTRACT

Low temperature hybrid thermochemical treatment in austenitic stainless steel leads to the formation of expanded austenite which consist of dual layer structure due to the simultaneous diffusion of nitrogen and carbon. The resultant layer can improve the surface mechanical properties of the stainless steel without deteriorates its corrosion resistance since the treatment is conducted in low temperature below 500°C. By using empirical approach and trial and error methods, it is difficult to understand the nature of the combined diffusion effect on the kinetic aspect of the hybrid layer development optimally. Besides, it is very time consuming and requires high cost. The present study aims to simulate the concentration-depth profiles as a result of the nitrogen and carbon simultaneous diffusion during low temperature hybrid thermochemical treatment in austenitic stainless steel by numerical modelling. The central explicit finite difference method is applied to calculate the diffusion equation in determining the concentration along the diffusion depth. The model incorporates several factors as another driving forces aside from concentration gradient as described by Fick's 2nd law including the concentration-dependent diffusion coefficient, the composition-induced stress, and the trapping. The concentration-depth profiles produced by the present model consists of convex and concave sections which differ from the standard error function solution. The results show that the diffusion process is accelerated as the concentration-dependent diffusion coefficient and the composition-induced stress are included in the model. When the trapping factors is added to the model, the outcome reveals that the diffusion depth decreases, and an abrupt drop is found in the concentration profiles of carbon. The effect of various process parameters towards the hybrid expanded austenite layer growth were also examined. It can be concluded that the typical concentration-depth profiles of nitrogen and carbon after low temperature hybrid thermochemical treatment in AISI 316L is successfully reproduced by the present model.

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