Effect of cooling rate on the HAZ′ s microstructure and properties of the CLAM steel by electron beam welding

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Abstract: The Reduced Activation Ferritic/Martensitic (RAFM) steels are being considered as the primary structure materials in fusion energy systems. The China Low Activation Martensitic (CLAM) steel is one of RAFM steels which is being developed in Institute of Plasma Physics, Chinese Academy of Sciences (ASIPP) under wide collaboration with many institutes and universities in domestic and overseas. It is considered as the candidate structure material for the DFLL-TBM (Dual functional lithium lead test blanket module) of China because of its attractive properties. And the EBW (electron beam welding) is one of promising joining technologies of the TBM due to many advantages.

In this study, with Gleeble-1500 thermal simulation test machine, the specimens subjected to simulating the HAZ (Heat Affected Zone) by electron beam welding of the CLAM steel at different cooling rates were obtained. The microstructure and properties at different cooling rates were analyzed by means of optical microscope, SEM (Scanning Electron Microscope) observations and micro-hardness test etc.. And then the effect of cooling rate on the HAZ's microstructure and properties was investigated. The effects of substructure of martensite and the distribution of carbides on the strength were investigated too. The results showed that when the cooling rates between 40℃/s and 2.5℃/s, an overall martensitic transformation was achieved and the martensite morphology presented as typical quenched microstructure- lath martensite, the values of the microhardness were higher than HV350 (the microhardness of base material was HV225). The substructure of the martensite showed high dislocation density but no precipitates, which indicated that both the over saturated solid solution and the very high dislocation density contribute to the hardness increase of the HAZ. In order to obtain better properties, an appropriate heat treatment, such as tempering, should be needed.

Topic: **I -** Materials Technology

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