Career Episode 2

Experimental Analysis of Shape Memory Alloys

A) Introduction

[CE 2.1] The work was done in the Materials Engineering field which had below details:

Project Name: Experimental Analysis of Shape Memory Alloys

Duration: [Date] – [Date]

Location: Malaysia

Position: Student

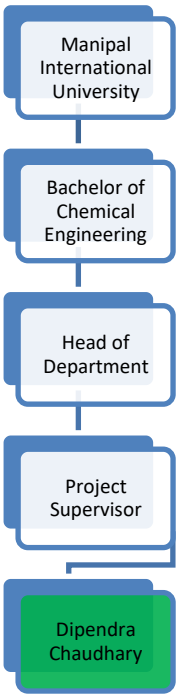
B) Background

[CE 2.2] A group of alloys is a shape memory alloys which was mainly for recovering the shape when mainly heated at the defined temperature. The memory effect shape mainly based on the martensitic transformation along with the diffusionless and reversibility of the transformation of phase. The low-temperature martensite phase is the point where it typically occurs among the high-temperature austenite phase. There are numerous copper alloys like copper aluminum, copper zinc-aluminum alloy, etc. There were copper-based SMA attracted because of the decent shape with the memory capacity, fabrication ease and lower cost of production.

[CE 2.3] The project aim was the experimental analysis with two copper zinc-aluminum alloys with the zinc content variable amount along with constant AL content. It was based on the preparation from the pure metals induction melting along with hot rolled into 0.5mm strip thickness which was process thermally with the usage of three various heat treatments. I adopted the different quenching techniques with the room temperature and boiling water. I analyzed the composition effects with various techniques of the heating treatment on the transformation temperature and microstructure investigation.

[CE 2.4] The project was done with the technical expertise usage in the material engineering field. It was the project mainly executed during my university degree journey under the assistance of the supervisor.

[CE 2.5] The developed project organogram:



[CE 2.6] I had these duties:

- I applied DSC research which was attained after the heat treatment with the usage of the simultaneous analyzer and it was accomplished using material engineering knowledge.
- I conducted the implementation of the step-quenching into the boiling water which was mainly done at the 100 degrees temperature and implementation was done with the material engineering skills usage.
- I executed the direct quenching at the water of room temperature which was followed with the up quenching supported with subsequent aging.
- I managed to get the DSC curves which was based on the determination of the austenite principle linked with the finalized temperature.
- I made implementation of the adequate exothermic detection when carried out the cooling runs testing.
- I executed the direct quenching process which was carried out at the water of room temperature and there was no adequate linking made with the subsequent aging.
- I worked on the two-phase alloys determination with the microstructure and it was based on the dendritic alpha particle inclusion along with the DSC structure.

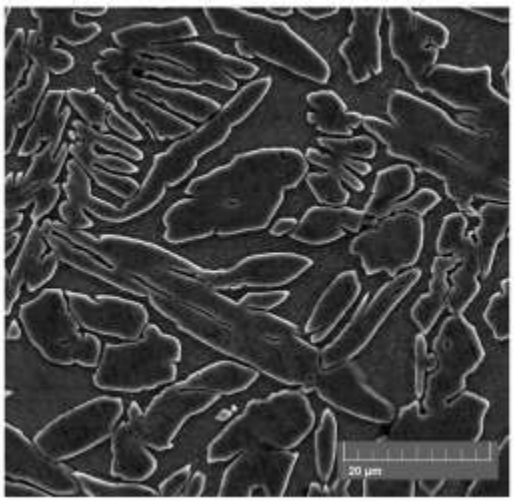
C) Personal Engineering Activity

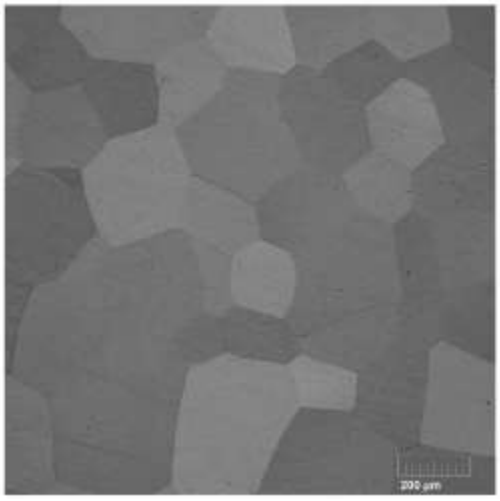
[CE 2.7] I did the Cu-Zn-Al alloys selection with the compositional principles along with the preparation using induction melting of the pure copper, aluminum and zinc quantities. I cast the

alloys into the graphite moulds which were ingots in the cylindrical bars form with about 10cm length and 1cm diameter. I analyzed the hot rolling of the ingots into 0.5mm thick strap and heating treatments were followed with the beta solutionizing at the temperature of 850 degrees for about 30 minutes. I then executed the direct quenching at the room temperature water and up-quenching with subsequent aging into the room temperature water at 100 degrees for about 25 minutes before the process of quenching again executed at the room temperature. I worked on the direct quenching process which was done at the room temperature of the water and it was linked with the subsequent aging. I then implemented the step-quenching into the boiling water at the temperature of 100 degrees with the remaining temperature left for 10 minutes. It then led to the cooled at room temperature with the samples mainly based on the scanned electron microscopy notifications.

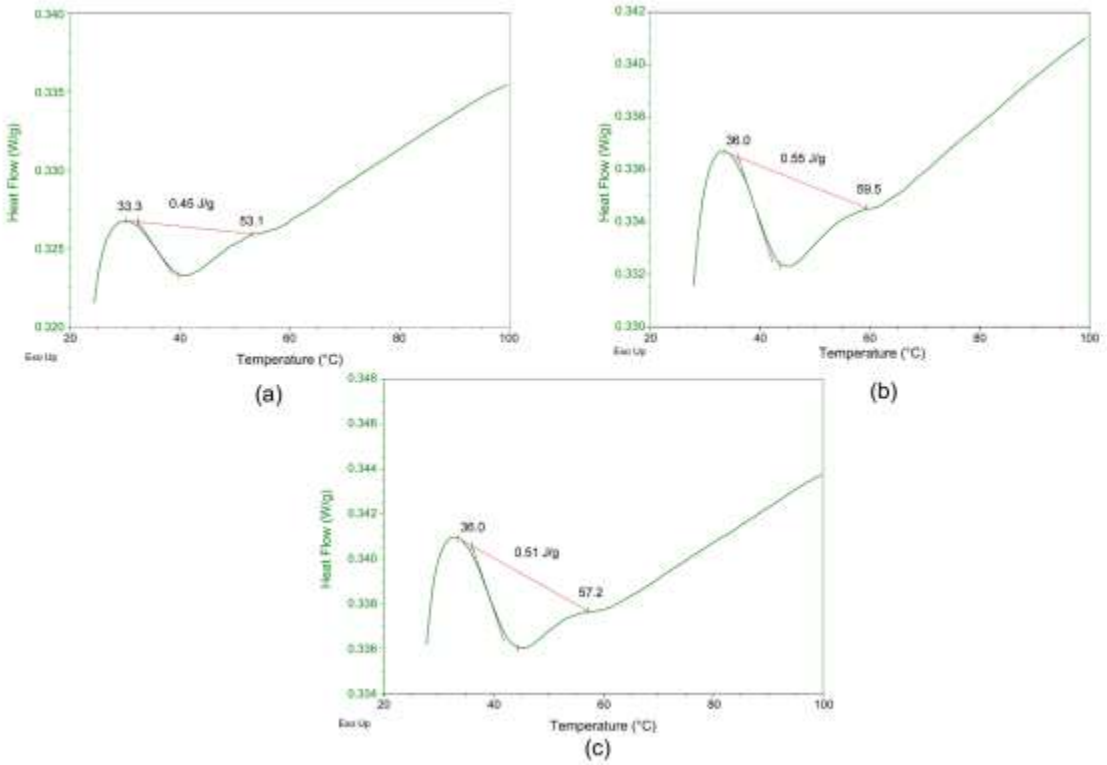
[CE 2.8] I worked on defining the aspects related to the dynamic behavior and applied adequate attention on the reductions of vibration. I made necessary assumptions in this regard and noted the variations in the temperature which included hysteretic and stiffness changes. I realized that these aspects were well in connection with the SMA systems behavior and it interacted well with the production of the dynamic response of the system. I obtained the liquidus projection with the phase diagram at the temperature of 800 degrees of the copper-zinc-aluminium system. It was done with the calculations utilizing optimized thermodynamic parameters from the software with the marked overall compositions. I attained the overall composition of the investigated alloys which typically belonged to the beta phase primary crystallization. I made the phase diagram calculations with the ternary system at a temperature of 800 degrees. I analyzed the overall composition of the investigated alloys which were present in the single beta phase region along with the overall copper-zinc composition and these were closed to the two-phase region of alpha and beta particles.

[CE 2.9] I adopted the phase and microstructures compositions of the copper-zinc and aluminum alloys which mainly worked on the SEM-EDS usage and investigation. I determined the microstructure of the two-phase alloy along with the inclusion of the dendritic alpha particles with the DCC structure. These were maintained irregularly and distributed with the beta matrix. These worked as the cast-copper aluminum alloy which had a single beta phase microstructure.





[CE 2.10] I performed DSC research after the treatments of heat based on the SDT Q600 simultaneous analyzer. I selected the DSC measurement samples which were mainly based on the compact thin flat form and these resulted in cutting from the strips using heat-treatment technique. I noted the investigation sample mass which was about 50mg. I conducted DSC measurements which were based on the heating runs at three points from the room temperature to the three 100 degrees temperature while maintaining the heating rate of 5 degrees per minute. I obtained the three heating runs DSC curves for the direct quenching which was in relation with the austenite start determination followed with the finishing temperatures. I obtained the austenite start temperature of the extrapolated peak onset value and determination was done as the peak-end set temperature during heating. I worked on presenting the summary results of DSC analysis and based on the determination, the transformation temperature was set in the intervals of 30 to 60 degrees.



[CE 2.11] I carried out DSC research of the directly quenched copper-zinc and aluminum alloy which was based on performing the DSC analyzer in two different thermal cycles mainly ranging from -50 degrees to 200 degrees. It assisted well in maintaining the same heating/cooling rate and transformation temperature was obtained on heating which was in relation with the results which was attained with the usage of the SDT device. I detected the two exothermic peaks when testing the cooling runs.

[CE 2.12] The technical skills were adopted in the project with the technical expertise usage in the domain of material engineering which was accomplished within the project defined timeline under the project guide excellent supervision. I attended the seminar related to material engineering and

discussed the factors with the project supervisor. I worked on the table creation, in the beginning, mentioning the main project goals which were then followed in the entire tenure of the project.

D) Summary

[CE 2.13] An analysis which I carried was mainly on the microstructure phase heating treatment along with the zinc, aluminum and copper transformation. I did the alloys preparation mainly done with the selection of pure metals along with the induction of hot-rolled heating into the thick strip of 0.5mm. I obtained the strips of alloy which was mainly subjected to the heat-treatment three different processes. I worked on attaining the steps which were in relation with the step-quenching, direct quenching and up-quenching and these were at the room as well as boiling water temperature. I carried out the thermal analysis investigation based on the microstructure results and it consisted of the microstructure with the alloy mainly consisted of the beta phase in the base. I obtained the irregular dendritic particle research with the distributed FCC structure well in the beta matrix. I used the copper-zinc-aluminum alloy which worked with the single-phase microstructure and it included higher beta phase polygonal grains. I did the up-quenching and direct quenching execution which worked fully with the martensitic microstructure in the copper-aluminum alloy. I induced the martensite with the implementation of the step-quenching and the copper-zinc sample also included the alpha phase of the small precipitates. I attained the heat-treatment which performed well with the induction of the martensite in the copper-aluminum alloy. It resulted in the martensite started temperature for the alloy which was under room temperature. I incremented my Material Engineering knowledge well with the project successful completion.