



CHAPTER 6

DISCUSSION AND CONCLUSION

In the Powder Metallurgy field, the powder shapes of Tungsten and Copper are irregular and about 90% have spherical shape (as shown in Fig. 8) rendering in low compactibility. Since Copper has particle size rather rough compared with the Tungsten particles, segregation easily occurs when mixing both powders together. So binder is necessary in mixing before the powder mixture is pressed. In the experiment after heat treatment at 800 C to expel the binder and lubricant out the pellets underwent further sintering process at 1000 C and 1200 C. The results showed that the microstructure of Copper was similar to each other, having the microstructure like the islands of very rough surface in the Tungsten matrix. The Copper powders diffused rapidly to each other when the green compact is soaked at 800 C or more due to its low recrystallization temperature (about 300 C). Only Tungsten particles had difference in microstructure. At 800 C, the Tungsten particles seemed to be unchanged, while at 1000 C the Tungsten particles began to coalesce or had bonding to each other. At 1200 C, Copper had a liquid state and the Tungsten particles coalesced becoming large particle connected together having very little entrapped Copper. The microstructure of Tungsten both before and after heat treatment had a skeletal structure and seemed to be

unchanged at different Copper contents so that the coarsening of the grain according to Lifshitz, Slyozov, and Wagner theory could not be applied or modified in this case. The main problem was the porosity and nonuniformity of the structure resulting from the unsuitable equipment used in mixing the powders.

In density determination by gamma transmission, this method had the advantages in the condition of porous materials over the weight to volume method in the condition of compacts sintered at 1200 C. But for the green compacts as in Table II the data obtained had higher density than the weight to volume method due to the too short counting time so that the statistical errors had an important effect in counting rate. This error can be eliminated by increasing the counting time. This technique has the limitation in case of nonuniform texture of irregular thickness of the material or both.

In Neutron Activation Analysis, the experimental results showed that both Detection Systems I and II could be used with a good results (see Table. 4,5 and Fig. 13,15). The problems encountered in the experiments were the quantity of the sample and the activity after activation, by neglecting the variations of neutron fluxes in the reactor, and the statistical errors. In Detection System I, the detected Copper peak had only one peak (0.511 MeV) while another peak (1.34 MeV) could not be detected due to its low efficiency, so that an error would be present when the Tungsten content was high (see Fig. 12). For Detection System II, both peak of Copper could be detected but due to the lower resolution of the NaI(Tl) detector

compared with Ge(Li) detector (see Fig. 14), the Copper content could not be determined directly by using the 0.511 MeV. The technique for determining the Copper content was to use the 1.34 MeV peak or applying subtraction technique (by using the 0.686 MeV peak of Tungsten as a standard in subtracting, this technique seemed to have better results than using the 1.34 MeV peak especially in the condition of high content of Tungsten compared with the Copper). The Table 13 and Fig. 15 are the results obtained from the subtraction method, using Detection System II. In activation analysis by using the Pu-Be source the results showed the self-shielding effect due to its low neutron flux and the size of the sample, but the Detection System II could be used successfully in the analysis of both elements.

In X-ray Fluorescence Analysis, the experiments were carried out in two systems of equipment:

- EDX system, this system could not be used in analysing the composition of Tungsten and Copper at the same time, because of the interference between the K X-rays of Copper and the L X-rays of Tungsten. Both the proportional counter (Detection System III) and Si(Li) detector (Detection System IV) were unable to resolve the energies represented by the two peaks. The only way in using these systems in the experiment is the analysis of Tungsten by detecting the K X-rays energies only.

- WDX system, this system is suitable to be used as a standard equipment due to the very high resolution of the system

(see Fig. 16) compared with the EDX system. In this system the K X-rays peaks of Copper and L X-rays peaks of Tungsten could be distinctively obtained owing to the high resolution of the system so that analysis of specimens of a mixture of Copper and Tungsten was possible. Due to the lack of standard specimens of Tungsten and Copper, the specimens for microstructural study of Copper Alloys, Tungsten Carbides, and Low Alloy Steels containing Tungsten were used in the experiments instead. The analysis of contents of both Copper and Tungsten mostly had good linearity as illustrated in Fig. 17,18, 19,20,21, and 22.

FURTHER SUGGESTION

In the Powder Metallurgy field, the size and shape of the metal powders will directly affect the process used in practice. So suitable selection of size and shape of the powders will largely reduce the problems that will occur in the experiments. The mixing and blending of metal powders and pressing into pellets will affect directly the sintered products properties. The high heating rate and the accurate temperature measurement is essential in the analysis of mechanism occurred in sintering. It is suggested that further study for Copper should be done at lower temperature, and the study concerning the uses of electrical contacts, the conductivity test, and the life cycle test of the sintered pellets should be done in future.

In the density determination by gamma transmission, all of the obtained results seemed to be rather high compared with the

conventional method, this may result from the unlikeliness of the matrix between the specimen and the standard used in the system. To avoid this problem, use of standards having the same matrix as the specimen will be essential in this case. The background of the system should be controlled as low as possible, while the intensity of the attenuated gamma should be as high as possible to reduce the statistical errors. The longer the time used in detection the better would be the results obtained. It should be born in mind that this technique is not suitable for irregular, nonuniform, and radioactive sample that emit radiations higher or nearly to the energy of the gamma source used in the experiment.

In Neutron Activation Analysis, the amount of the sample and the activity after activation will be the important problems encountered in the analysis. This technique is suitable for specific analysis of the amount of the required elements especially the trace element, but, for qualitative analysis of the sample the composition of which is not known before, use of this technique alone may become unsuitable. Due to the very little amount of specimen used in activation analysis, the study of shielding effect that may occur both in the activation and in the analysis of the spectrum cannot be done in these experiments. Since the elements used in the experiments are in metallic form, the induced activity was very high comparing with the general specimens.

In X-ray Fluorescence Analysis, both EDX and WDX methods are comparatively fast analysis of the unknown specimen.

The EDX method is suitable for analysing the elements having the characteristic X-rays energies rather far apart enough for the detector to resolve the energies clearly. Due to the limitation of the detector resolution, this method of analysis cannot be used extensively in analysis of metals and alloys in heavy industries.

The WDX method will give more accurate results than the EDX method, but, due to its slowness of scanning mechanism and its very high capital cost, it is not widely used in industries as the EDX method. The main limitation of both methods in analysis is the matrix effects in the metallurgical specimens, that cannot be eliminated as in the powder form of ores specimens.

It can be concluded that in applying nuclear techniques such as NAA and X-ray Fluorescence Analysis to the metallurgical field the limitation of each method of analysis should be born in mind. So in order to obtain the best result of analysis, these methods should be used in parallel.