A COMPARATIVE, LABORATORY, ANALYTICAL (EVALUATORY, PHYSICO - MECHANICAL AND MICROSTRUCTURAL) STUDY OF MODIFIED NICKEL - CHROMIUM ALLOY AND THE SELECTION OF THE PROPOSED BEST ALLOY SYSTEM

Thesis

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In

Dental Materials

By

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SUMMARY

* Materials used:

1. Already available type of Ni-Cr alloy (sankin)
2. Recommended type of phosphate bonded investment (Hi-temp. 2).
3. Pure silver and pure copper (99.9 purity).

* Copper mould was especially fabricated to gain the wax patterns used in the study.

* Addition groups of the study:

The proposed alloy systems were divided into three groups

1. "Cu" addition group: including five alloy systems containing the added Cu % wt.
2. "Ag" addition group: including five alloy systems containing the added Ag % wt.
3. "Cu-Ag" addition group: including five alloy systems containing the added "Cu+Ag" %/wt.

These fifteen alloy systems were compared with the basic Ni-Cr alloy and with each others to select the best alloy system / systems.

* Tests and testing devices of the study:

1. Tension test: including:

a) U.T.S. b) Elongation %

It was achieved by the "Instron" tensile testing machine. Model 1195 instrument.

2. Hardness test: was achieved by "Vickers" hardness tester model HPO 250.

3. Microstructure test: was achieved by "metallographic microscope", model Leitz Dialux 20.

4. Corrosion test: was achieved by a "computerized potentiostat" model 350 A (EG and G Parc).

* The results of this study showed that:

- Copper has mild increasing effect on the U.T.S. of the basic alloy while silver has a more pronounced increasing effect on it.
- It is better to add both metals together to the basic alloy to gain more pronounced effect on the U.T.S.
- Alloy system A_1C has the highest U.T.S. value (73 kg/mm^2) while, alloy system A_5C has the lowest U.T.S. value (44 kg/mm^2).
- Copper and silver have gradual increasing of effect on elongation %) except for a slight drop in both C_3 and A_2 alloys values.
- The addition of both metals together to the basic alloy has a more powerful effect on increasing ductility.
- Alloy system A_1C has the highest elongation % value (3.6 %), while, alloy system C_1 has the lowest elongation % value (1.3%).

- The results of the hardness test showed that all alloy systems gave lower hardness values than that of the basic one, except for alloys C_3, C_4 and C_4.
- Alloy system C_5 showed the highest hardness value (336) while, alloy system A_3 showed the lowest hardness value (182).
- In the "Cu-Ag" addition group, the decrease in hardness values was gradual and smooth.
- Metallographic examination revealed that the addition of copper and silver to the basic alloy had a great effect on the microstructure and was a consequence, the physico-mechanical and chemical properties were affected.
- The results of the corrosion test indicated that the addition of copper led to improvement in corrosion resistance except for alloy C_4, the addition of silver led to a decrease in corrosion resistance except for alloy A_1 and the addition of both metals together in alloys A_3C and A_4C showed pronounced increase in corrosion resistance.

CONCLUSION

This trial research work showed that it is possible to improve or modify chemico-metallurgical and physico-mecanical properties of any alloy by adding some definite minor alloying elements following the correct metallurgical methods of alloying.

From the present results, one may conclude that:

The addition of copper and silver to the basic Ni-Cr alloy affects greatly the physico-mechanical and chemico-metallurgical properties of this alloy in the following ways:

1. The addition of "Cu" has mild effect on U.T.S., it causes moderate increase in elongation % and also moderate increase in hardness values especially at high percentages. Finally, it helps to improve corrosion resistance of Ni-Cr alloys.

2 The addition of "Ag" leads to improve in ductility property to increase in U.T.S. and to decrease in hardness values but not in a regular manner. Silver does not help to improve corrosion resistance especially at high percentages.

3. The addition of both copper and silver together leads to a better and pronounced improvement of physico-machanical properties than that caused by the addition

of each metal separately, since as mentioned before, corrosion resistance was improved in alloy systems A_3C and A_4C.

The exceptions of the above conclusions were usually coming from the difficulty of obtaining regular and smooth results during research work progress due to many technical and metallurgical factors which as previously mentioned were very difficult to control.

4. Alloy systems A_3C and A_4C are the best modified alloys of choice because they show improvements in all mechanical and chemicometallurgical properties.