

The importance of heat treating nickel based alloys used in fixed prostheses technology

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Affected

INTRODUCTION: Nickel alloys may be subjected to different types of pre- and post-weld heat treatments, depending on the chemical composition, fabrication requirements and intended use. Ni-Cr alloys used in dental technology belong to the precipitation hardened alloys and their mechanical properties are developed by heat treatment to produce a fine distribution of particles in a nickel rich matrix [1-4]. The purpose of the study was to evaluate the effect of heat treatments on microplasma welded Ni-Cr alloys with different composition used in dental technology, by metallographic analyses and microhardness tests.

METHODS: The casting alloys used in this study were Ni-Cr alloys: Wirolloy (Ni 63.2, Cr 23.0, Fe 9.0, Mo 3.0, Si 1.8, C <1.0, Bego, Bremen, Germany), Wirolloy NB (Ni 67.0, Cr 25.0, Si 15.0, Mo 5.0, Mn, Nb, B, C <1.0, Bego, Bremen, Germany). For the experimental study 16 plates were cast conventionally using an induction melting centrifugal casting machine Orcacast (II dental, Budapest, Hungary). Half of them were cooled slowly at room temperature and half quickly, quenching them in cold water. After casting, the plates were divested, air abraded with 250µm Al₂O₃ particles, grinded and prepared for welding by polishing and degreasing. The plates were matched and welded using microplasma Welder (Schütz-Dental, Rosbach, Germany). Each specimen was bilaterally welded in a butt joint configuration, with a spot overlapping of more than 60%, using 0.5 mm in diameter wolfram electrode for joining and 1 mm diameter for surface fining. The pulse delay was maintained at 30 ms and the argon quantity at 5-6 l/min in all cases. The used power step was 8 for joining and 4 for fining. Half of the welded specimens were heat treated using a furnace (Sirio 720S, Sirio Dental, Meldola, Italy), 60 min at 800°C and then cooled uniformly to room temperature. They were analyzed metallographic, and the microhardness was determined in the base metal (BM), weld metal (WM) and heat affected zone (HAZ).

RESULTS: Cracks appear along the joining line and are propagated along the grain boundaries (Fig. 1). The cracks and the modification of the microstructure due to the rapid heating and

solidification process can be a real problem and affect the quality of the weld.

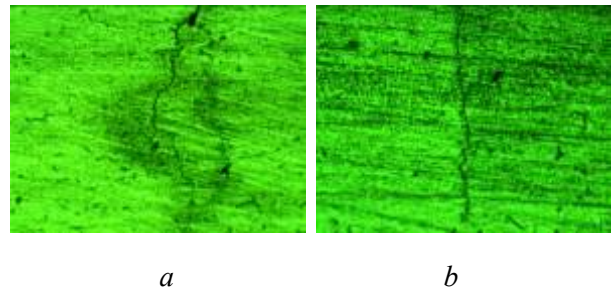


Fig. 1. Metallographic aspect of a crack in the WM for: a. Wirolloy, b. Wirolloy NB.

The dendritic microstructure of the BM became finer especially for Wirolloy (Fig. 2) and the microhardness values decreased after after heat treatments for Wirolloy and increased for Wirolloy NB.

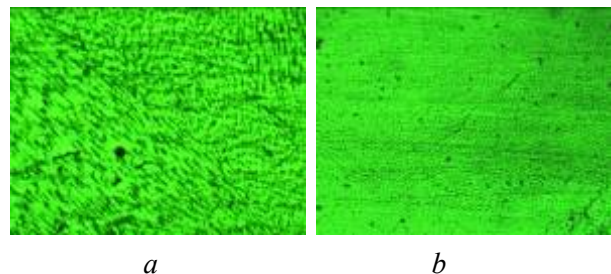


Fig. 4. Metallographic aspect of the WM: a. before heat treatment, b. after heat treatment.

DISCUSSION & CONCLUSIONS: Even the chemical composition of the alloys was similar; their behavior at heat treatment was different. Therefore it is important that the heat treatments procedures be particularized for each alloy type. The microhardness reduction was obtained only for Wirolloy. Regarding the metallographic structure, the most affected by heat treatment was the same alloy.

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ACKNOWLEDGEMENTS: This study was supported by the Grant CNCSIS_171 from the Ministry of Education and Research, Romania.