Corrosion resistance of laser-welded CoCrMoW alloy used in prosthodontics

Dr Łukasz Reimann, Silesian University of Technology, Gliwice, Poland (presenter)

Abstract

Statement of the Problem: Corrosion resistance in one of the criteria in the selection of denture materials, while the most popular joining method in dental engineering to repair broken fixed dentures is the laser beam welding (LBW). Application of this technology give an opportunity to works with or without filler material. This study aims to evaluate the corrosion resistance in the artificial saliva environment of LBW joints in various configurations of CoCrMoW alloy welded without and with nickel-free stainless steel, cobalt-chromium alloy as filler material. The samples were laser welded using laser welding machine Nd: YAG LaserStar Plus with the following parameters: 8 ms pulse duration, spot diameter 0.7 mm, and voltage of 270-290 V. The corrosion tests were performed by electrochemical methods registering anodic polarization curves in artificial saliva and the microstructure was assessed by light and scanning microscopy. Welding CoCrMoW alloy without and with a filler material increased the open circuit potential of the samples by 40 - 100 mV. For both types of filler materials the polarization resistance decreased compared to the base alloy while compered of the two filler metal better results were found for stainless steel wire J_{corr} = 12.7 nA/cm^2, while for CoCr wire it was 35 nA/cm^2, and the polarization resistance was higher by 50 kΩ·cm^2 for stainless steel wire. The structure of the tested materials, as-cast CoCrMoW base alloy shows dendritic micro-structure with interdendritic lamellar precipitates of secondary phases and after use of filer materials in the LBW results in refinement of the structure as compared to the non-welded one.

Conclusion & Significance: The results allow to formulated conclusions that alloy welded with the filler material showed lower anticorrosion properties than the CoCrMoW base alloy. The alloy welded with stainless steel wire show slightly better electrochemical parameters in all corrosion tests performed during research.

Image

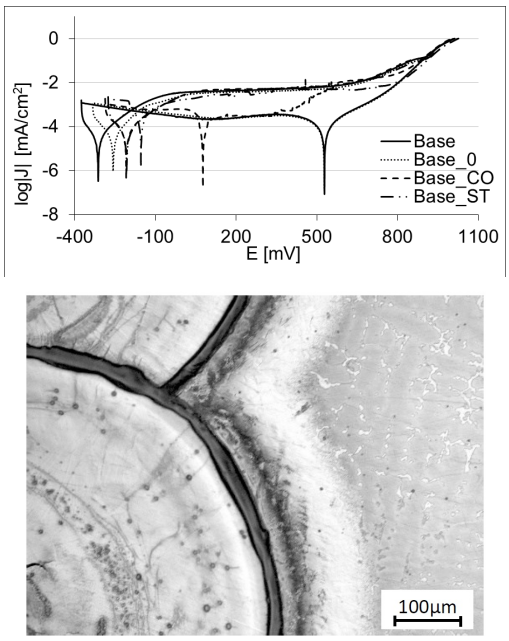

Fig. 1. Results of studies of welded CoCrMoW alloy: a) anodic polarization curves; b) microstructures

Recent Publications

1. Perveen A., Molardi C., Fornaini C. (2018) Applications of Laser Welding in Dentistry: A State-of-the-Art Review. Micromachines (Basel). 28;9(5):209 DOI: 10.3390/mi9050209.
2. Uriciuc, W.A.; Vermeșan, H.; Boșca, A.B.; Ilea, A. (2018) Interaction of Saliva with Cobalt-Chromium-Based Dental Alloys in Casted Prosthetic Pieces. Curr Trends Biomedical Eng & Biosci. 14(2): 555882. DOI:10.19080/CTBEB.2018.14c.555882
3. Ghiban, A.; Buzatu, M.; Bortun, C.M.; Ghiban, B.; Serban, N. (2015) Laser welding optimization procedure applied to cobalt alloys for removable partial dentures, Advanced Materials Research Vol 1114, 272-277, DOI:10.4028/www.scientific.net/AMR.1114.272.
4. Muguruma, T.; Iijima, M.; Mizoguchi, I. (2018) Corrosion of laser-welded stainless steel orthodontic wires, Orthodontic Waves, 77:1, 18-23, DOI: 10.1016/j.odw.2017.12.004.
5. Reimann, Ł. (2016) Electrochemical Characteristics of a Cobalt Alloy with a Protective Passive Layer, Archives of Metallurgy and Materials 61/3 937-944.

Photograph

Biography

Dr Łukasz Reimann is an employee of the Research Materials Laboratory on the Silesian University of Technology. The area of his scientific activity are materials using as biomaterials especially in dental engineering. He investigates the properties of materials and amoung his scientific interests he can mention corrosion research of metallic materials with use electrochemical techniques like polarization test and electrochemical impedance spectroscopy. In his research work, he uses computer-aided systems in design and manufacturing, especially in dental engineering, and realizes numerical simulations of load analysis using the finite element method.

Email: lukasz.reimann@polsl.pl