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Laser Sintering Technology for Co-Cr alloys

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Introduction

An alternative for the use of Co-Cr alloys is the laser sintering technique. Selective laser sintering (SLS) is a manufacturing technique that uses a high power laser (CO2 laser) to fuse small particles of metal powders (Direct Metal Laser Sintering) into a mass representing a desired 3-dimensional object. The laser selectively fuses metal powders by scanning cross-sections generated from a 3-D digital description by CAD file or scans data on the surface of a powder bed. After each cross-section is scanned, the powder bed is lowered by one layer thickness, a new layer of material is applied on top, and the process is repeated until the part is completed.

Material and Methods

The topography of the dental restoration is designed by numerical monitoring after having scanned devised prostheses (Fig. 1). The laser is thus programmed in such a way that it only becomes active at the site where the element should be achieved. The alloy particles will be sintered by the laser energy (Fig. 2). In our application the alloy consists of 64-67% Co, 28-30% Cr and 5-6% Mo, and has at equilibrium of a γ monophasic structure. Evaluation and characterisation was made by: Microstructure analysis; Corrosion resistance evaluation; Polarization test; Crevice corrosion test; Release of cations using Test Milieu, Fusayama Artificial Saliva, Solution 0.1 M NaCl 0.1 M Lactic Acide (ISO 1562:2004)

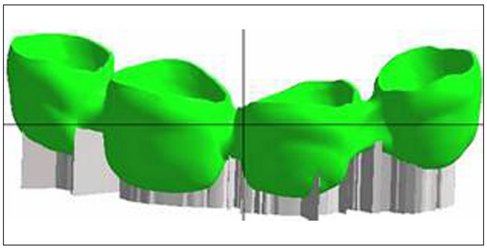

Fig. 1: Scan data virtual image of an element programmed with its foot

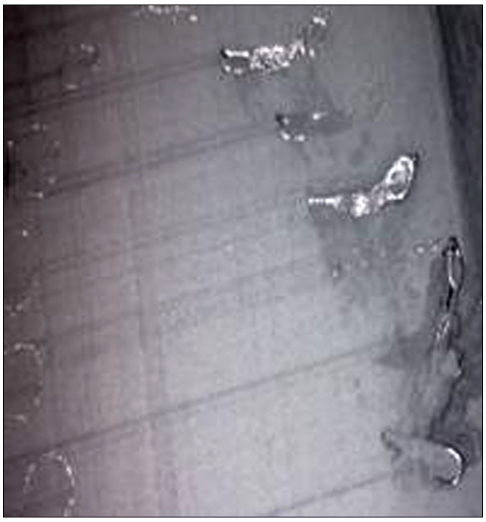

Fig. 2: The laser selectively fuses metal powders from a 3-D description of the CAD file or scan data

Results

Dimensional observations of Co-Cr restorations show that adjustment leads to satisfactory clinical results with a precision of 25 µm. The average hardness is 395HV, comparable to metallo-ceramic elements obtained by casting technique. The metallographic observations show a slight porosity in the horizontal, sintering plane (Fig. 3,4). Punctual analysis shows a high regularity of the local chemical composition: 62.6-64% Co, 29.3-30.5% Cr and 4.9-6.4% Mo. Potentiodynamic polarization curves confirm the presence of the porosity in the structure of the restoration (Fig. 5). Curve #1 is drawn after 4 h of immersion and curve #2 after 72 hours. SEM micrograph of the corroded surface after the polarization test (Fig. 6) shows spectre 1: O 24.53, Na 1.19, Si 1.12, Cl 0.59, Cr 28.76, Co 34.30, Mo 9.52.

Fig. 3: Porosity in the Co-Cr structure of layers

Fig. 4: Pile of the layers of Cr-Co

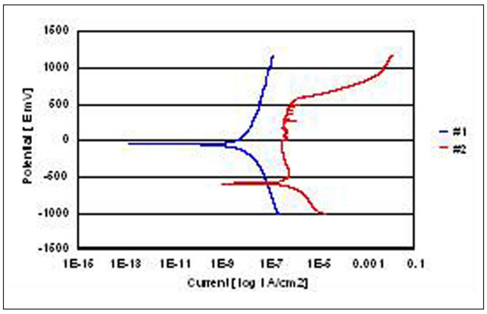

Fig. 5: Polarisation curves in Fusayama saliva

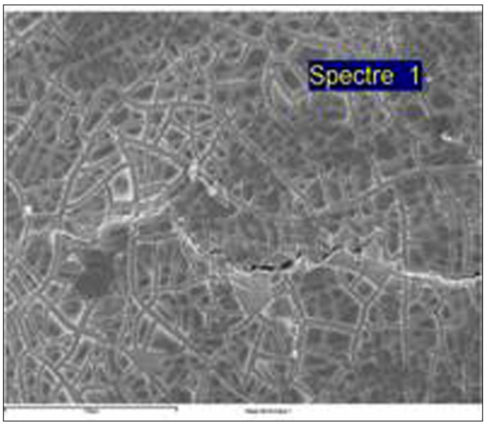

Fig. 6: SEM micrograph of the corroded surface after the polarization test

Conclusions

The technique of manufacturing by selective laser sintering allows obtaining prosthetic elements of high dimensional precision which present mechanical properties in agreement with the clinical requirements (Fig. 7,8).
However, the residual porosity inherent to the sintering process may present a risk for fracture and crevice corrosion.

Fig. 7: Prosthetics restorations obtained by laser sintering

Fig. 8: Sandblasted prosthetic restorations (with silica powder)

This Poster was submitted by Prof. Dr. Lavinia Ardelean.

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Poster Faksimile:

Laser Sintering Technology for Co-Cr alloys

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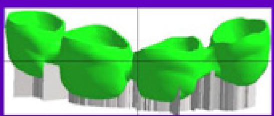

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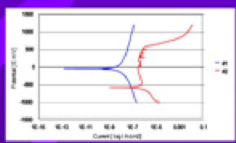

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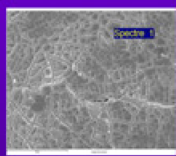

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