Composition Changes according to the Manufacturing Method of Dental Alloy Powder for Application of Selective Laser Melting System

Huisung Lee[1], Chongju Lee[1], Mihye Kim[1], Changhyung Lee[1], Sungmin Choi[2] and Hyeogju Kim[1]
[1]Medical Device Research Division, Pharmaceutical and Medical Devices Research Department, National Institute of Food and Drug Safety Evaluation, Chungcheongbuk-do, Korea. [2]Catholic University of Pusan, Busan, Korea.

Statement of Purpose:

In general, 3D printing is widely used as rapid prototyping(RP) for manufacturing test products. Recently, 3D printing using alloy powders is applied to increase mechanical strength(Butscher A., Acta Biomater., 2013;11:9149 -9158). 3D printing using alloy powders is called as selective laser melting/sintering(SLM, SLS) or Direct laser melting(DLM). Currently, SLM is adopted to medical and dentistry industries(Hong MH., J Dental Biomechanics, 2014;5:1-9). SLM can be classified as laser, 3D platform and processed materials. The properties of these substances affect quality of products, especially, a melting point and powder shape. Therefore, a research has being conducted with regards to metallurgical features and how to process powder(Han SW., Transaction of materials Processing, 2014;23,5:303-310).

According to the previous researches, productivity will be improved if process efficiency and accuracy are increased by controlling properties of processed materials. Therefore, this research intends to analyze that Ni-Cr alloy having a lower melting point is processed into powders and observe whether it can be used as processed materials of SLM.

Methods:

Metallurgical analysis was conducted on 4 types of processed SLM and alloy powders and substances and shapes of processed alloy powders were analyzed by a scanning electron microscope. Acceleration voltages and currents of a scanning electron microscope (FE-SEM; LEO SUPRA 55; Carl Zeiss, Germany) are 10keV and 10nA respectively and its observation scale is ranged between 40 and 250. For analysis, the surface of alloy powder was coated with gold and energy dispersive spectroscopy(EDS) was conducted quantitatively.

Table 1. Produced dental SLM alloy

Specimens Code	Produced methods
NS	Nozzle Spouting
BM1	Ball Milling (Time:10hr)
BM2	Ball Milling (Time:20hr)
BM4	Ball Milling (Time:40hr)

Results:

After observing alloy powders, substances were reduced compared to NS CON, which is the original composition of NS alloy. Compared to BM CON, which is the original composition of BM alloy, substances of test products, BM1, BM2 and BM2 were reduced. The shape of test product, NS is round, while BM has a rather rigged particle shape. The results of this study Table 2, Figure 1 are as follows.

Table 2. Results of component observation of specimens.

Element	Composition (wt%)					
	NS CON	NS	BM CON	BM1	BM2	BM4
Ni	68	47.43	60	50.41	58.49	59.86
Cr	22	16.64	23	13.51	13.94	17.33
Mo	9	03.41	5	05.09	03.66	04.35

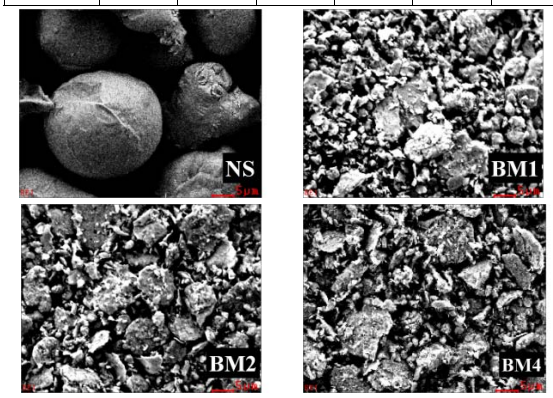

Figure 1. Shape of the alloy powder

Conclusions:

Nozzle Spouting and ball milling were tested to analyze the way to process Ni-Cr alloy into powder. As the results, Ni and Cr of powders processed by nozzle spouting were reduced and the powder analyzed by a laser test has a regular round shape. To apply SLM on Ni-Cr alloy powders, it should be designed after considering substance changes of composition after processing it into powder by nozzle spouting. The way to process subjects into round shapes is required for using ball milling. Through this kinds of additional research, Ni-Cr alloy powder will be able to be used as process materials of SLM.

Acknowledgment:

This research was supported by a grant (14171MFDS331) from Ministry of Food and Drug Safety in 2014