MECHANICAL PROPERTIES AND THE MICROSTRUCTURE OF THE PLASMA-SPRAYED $ZrO_2Y_2O_3$ / $ZrO_2Y_2O_3$CoNiCrAlY/ CoNiCrAlY COATING

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DOI: 10.5937/vojtehg65-10586

FIELD: Chemical Technology
ARTICLE TYPE: Original Scientific Paper
ARTICLE LANGUAGE: English

Summary:

ZrO_2 stabilized with Y_2O_3 has superior and excellent physical properties compared to other modern ceramic materials. Due to its high biocompatibility, ZrO_2 ceramics in the ZrO_2 - Y_2O_3 system is widely used as a biomaterial in orthopedic surgery. ZrO_2 - Y_2O_3 ceramics is widely applied in the production of the head of the hip, knee prosthesis, temporary holders, and more. ZrO_2 is used for a total hip replacement (THR), for an artificial knee joint as well as for the application and development of other medical devices. In order to use $ZrO_2Y_2O_3$ ceramics (YSZ) in biomedical substrates, it is necessary to deposit coating layers without defects. For the purpose of the deposition of a $ZrO_2$8wt.%Y_2O_3 ceramic coating with the best structural properties, the $ZrO_2Y_2O_3$ / $ZrO_2Y_2O_3$CoNiCrAlY / CoNiCrAlY coating system was tested. For financial reasons, the deposition was performed on a steel substrate by applying a CoNiCrAlY bond coating, which does not affect the structure and functionality of the $ZrO_2Y_2O_3$ ceramic layer. The structure of the layers was tested by the method of light microscopy, and the surface of the upper $ZrO_2$8wt.%Y_2O_3 ceramic coating was tested by the method of scanning electron microscopy (SEM). The obtained characteristics showed that the porosity content in the ceramic layer was not high and that micropores were uniformly distributed. The mechanical properties of the layers were assessed by testing microhardness using the method $HV_{0.3}$ and tensile bond strength using tensile testing.

ACKNOWLEDGEMENT: The author is thankful for the financial support from the Ministry of Education and Science of the Republic of Serbia (national projects OI 174004).

The values of the microhardness of the $ZrO_2 8wt.\%Y_2O_3$ coating were satisfactory as well as the tensile bond strength of the coating system.

Keywords: *ZrO_2, Y_2O_3, property, microstructures, mechanical properties, layers, coatings, ceramics, bonding.*

Introduction

Zirconium dioxide ZrO_2 ceramics has one of the lowest thermal conductivity values, and is therefore widely used as a thermal insulator at elevated temperatures (Mrdak, et al., 2013, pp.559-567), (Mrdak, et al., 2015, pp.337-343), (Mrdak, 2016, pp.411-430). $ZrO_2Y_2O_3$ ceramic coatings generally have excellent physical characteristics. Due to its stability, high biocompatibility and good physical properties such as high flexural strength of 900-1200 MPa, hardness of 1200 HV and Weibull modulus of 10-12, zirconium dioxide ZrO_2 is widely used in the process of manufacturing implants (Piconi, Maccauro, 1999, pp.1-25). In recent years, research efforts have focused on developing the ZrO_2-Y_2O_3 system as a biomaterial in orthopedic surgery for producing hip implant parts, characterized by the microstructure of a metastable tetragonal lattice (Piconi, Maccauro, 1999, pp.1-25). In order to use zirconium dioxide ZrO_2 as a functional biomedical coating on substrates, ceramic coating layers must be deposited without defects. The first systems of ZrO_2-Y_2O_3(YSZ) coatings stabilized with Y_2O_3 were of 12 – 20wt.%Y_2O_3, which fully stabilized the cubic c - phase. Later, tests showed that better performances can be achieved by reducing the levels of oxides Y_2O_3 to 8wt.%. The $ZrO_2 8\%Y_2O_3$ system is now widely used because it is standardized and has the status of an ISO standard for surgical application (ISO standard 13356, 2008, revision of a previous version of 1997). Tests of $ZrO_2 8\%Y_2O_3$ ceramic coatings have shown that they do not cause any cytotoxicity in living cells; therefore, they are biocompatible (Lang, Mertens, 1990, pp.606–611), (Dion, et al., 1994, pp.18-24). Previous studies and tests relate to the $ZrO_2Y_2O_3$ system with 8wt.%Y_2O_3, which is most commonly used in practice, and deposited by APS and VPS depositing processes (Mrdak, 2015, pp.137-159). The coating has a lot of good features, such as a high coefficient of thermal expansion of $11 \times 10^{-6}K^{-1}$, a low density of 6.4 g/cm^3, a low modulus of elasticity and high hardness, which provides better wear resistance. In addition, it has been proven that ZrO_2 coatings with 8wt.%Y_2O_3 are corrosion resistant to body fluids, which makes them bioinert. Compared to other industrial applications, biomedical coatings are a relatively new class of applications (Weidian, 2006), (Wang, 2008), (Heimann, 2006, pp.2012-2019), (Hong, et al., 2004, pp.317-326). Types of coatings applied in the artificial knee joint are mainly: hydroxyapatite (HA), zirconium dioxide (ZrO_2), aluminum oxide (Al_2O_3), titanium dioxide (TiO_2) and chromium oxide (Cr_2O_3). Increasing demands for improved efficiency of hydroxyapatite (HA) have influenced the development of many types of multiphase biomedical coatings. Some of the developed coating systems are HA/$ZrO_2Y_2O_3$(YSZ). Zirconium dioxide $ZrO_2Y_2O_3$(YSZ) is one of the most important bioinert oxides which is used in manufacturing implants. The results showed that the addition of $ZrO_2Y_2O_3$(YSZ) from 40 to 60vol.% to hydroxyapatite significantly reduces the decomposition of HA during the powder deposition by plasma spraying. A higher content of zirconium dioxide $ZrO_2Y_2O_3$(YSZ) increases the proportion of crystalline HA, and reduces the proportion of the amorphous phase in the coating. ZrO_2-Y_2O_3 ceramics reduces the share and size of pores in the coating and increases the coating hardness, wear resistance, adhesion, and cohesive strength when compared to a pure HA coating (Khor, et al., 2000, pp.160-166), (Morks Magdi, Kobayashi, 2007, pp.47-51). Biomedical coatings consist of at least two layers: bond / ceramic or more layers (bond / bond + ceramic / ceramic layer). In order to reduce stresses in the coating and at the interface between the substrate and the coating, three-layer coating systems are often produced.

For the deposition of the $ZrO_2Y_2O_3$ coating with functional characteristics, the $ZrO_2$8wt.Y_2O_3(YSZ) powder was deposited in the $ZrO_2Y_2O_3$ / $ZrO_2Y_2O_3$CoNiCrAlY / CoNiCrAlY system; because of the economic effect, cheaper substrate and bonding coating were chosen since they do not affect the microstructure of the functional $ZrO_2Y_2O_3$ coating. The bonding and cermet coatings were deposited by the VPS process, while the $ZrO_2$8wt.%Y_2O_3 ceramic coating was deposited by the APS process. This paper focuses on the testing of microhardness, microscopic and macroscopic defects in $ZrO_2Y_2O_3$ coatings such as peeling of layers, pores on the coating surface, coarse unmelted particles, coarse pores, micro and macro cracks in the coating layers and on the coating surface, all of which have a negative impact on the mechanical properties of the $ZrO_2Y_2O_3$ coating. The test results have shown that there are no coarse particles, macro pores, cracks and other defects on the surface of the $ZrO_2Y_2O_3$ coating. The presence of a certain quantity of micro-pores in the ceramic coating is normal and the content of the pores in the coating was in accordance with the standards of this coating. The layers on the surface of the $ZrO_2Y_2O_3$ coating show that powder particles are uniformly deformed and smooth and as such can be applied in the field of biomedicine.

Materials and experimental details

To create a three-layer coating, the Sulzer Metco powder types marked AMDRY 9951 and Metco 204F were used. The AMDRY 9951 powder is a superalloy Co32Ni21Cr8Al0.5Y. The powder particles are spherical, which provides a good flow of the plasma jet. Figure 1 shows the scanning electron micrographs (SEM) of the morphology of powder particles. The granulation range of powder particles was from 5 μm to 37 μm (Material Product Data Sheet, 2011, AMDRY 9951, Cobalt Nickel Chromium Aluminum Yttrium (CoNiCrAlY) Thermal Spray Powders, DSMTS – 0092.1, Sulzer Metco).

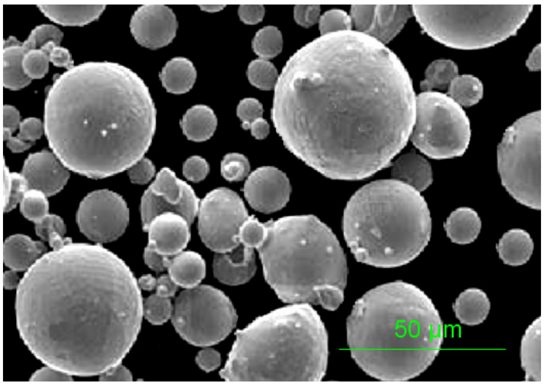

Figure 1 – (SEM) Scanning electron micrography of CoNiCrAlY powder particles
Рис. 1 – (SEM) Электронная микрография частиц порошка CoNiCrAlY
Слика 1 – (SEM) Скенинг електронска микрографија честица праха CoNiCrAlY

A mechanical mixture of AMDRY 9951 and Metco 204F powders (35% (Co32Ni21Cr8Al0.5Y) + 65% ($ZrO_2$8wt.%Y_2O_3)) was used to produce a transitional cermet layer. The upper ceramic coating was produced from Metco 204F ($ZrO_2$8wt.%Y_2O_3) powder. The powder was produced by the method of agglomeration and HOSP granulation from 15 μm to 45 μm. Figure 2 shows the scanning electron micrographs of the morphology of $ZrO_2$8wt.%Y_2O_3 powder particles. The powder particles have a regular spherical shape (Material Product Data Sheet, 2012, Metco 204F, 8% Yttria Stabilized Zirconia Agglomerated and HOSP™ Thermal Spray Powders, DSMTS-0001.2, Sulzer Metco).

The material on which the coating layers were deposited was X15Cr13 stainless steel (EN 1.4024) in the untreated condition. The mechanical characteristics of the coating layers were tested in accordance with the Pratt & Whitney standard (Turbojet Engine – Standard Practices

Manual (PN 582005), 2002, Pratt & Whitney, East Hartford, USA). The substrates on which coatings were sprayed for microhardness testing and evaluation of the microstructure in the deposited condition were made of steel Č.4171 (X15Cr13 EN10027) in a thermally unprocessed condition with the dimensions 70x20x1.5mm.

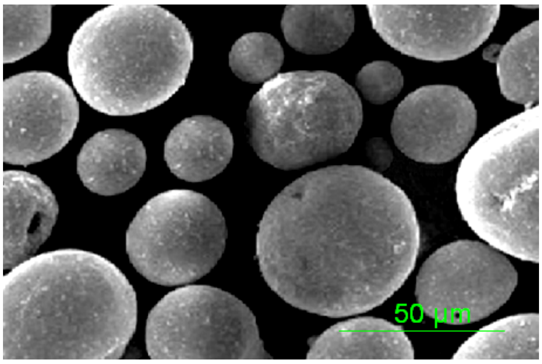

Figure 2 – (SEM) Scanning electron micrography of ZrO2 8%Y2O3 powder particles
Рис. 2 – (SEM) Электронная микрография частиц порошка ZrO2 8%Y2O3
Слика 2 – (SEM) Скенинг електронска микрографија честица праха ZrO2 8%Y2O3

The substrates for testing bond strength were made of the same steel in the untreated condition with the dimensions Ø25x50mm. The microhardness of the layers was tested by the method $HV_{0.3}$ and their bond strength by tensile testing.

The microstructure of the deposited layers was examined under a light microscope. The share of micro pores in the coating was analysed by treating 5 photos at 200x magnification. This paper presents the mean values of the share of pores in the coating.

The bonding and cermet coating powders were deposited with the vacuum plasma spray system of the Plasma Technik AG company and with an F - 4 plasma gun, with controlled plasma spray parameters. The powders were deposited with a mixture of plasma gases Ar-H_2. Before the deposition of bonding and cermet coating powders, the **s**ubstrate surface was cleaned with a transferred arc with a mixture of gases Ar-He. The CoNiCrAlY bonding coating powders were deposited with the optimum deposition parameters (Mrdak, 2013, pp.26-47). Table 1 shows the VPS parameters of powder deposition. The bonding layers were deposited with a thickness of 50 µm - 60µm and the cermet layers with a thickness of 100 µm - 110 µm.

The deposition of Metro 204F ($ZrO_2$8wt.% Y_2O_3) ceramic powders was performed with an atmospheric plasma spray system of the

Plasmadyne company and with an SG-100 plasma gun, with controlled plasma spray parameters. The SG -100 plasma gun consisted of a cathode type K 1083 - 129, anode type A 1083-165 and a gas injector type GI 1083 - 113. Ar was used as an arc gas in combination with He and the power supply of up to 40 KW.

Table 1 – VPS plasma spray parameters
Таблица 1 – VPS параметры плазменного напыления
Табела 1 – VPS плазма спреј параметри

Parameters	Values		
	Cleanin g arc	Spraying CoNiCrAlY	35% (CoNiCrAlY) + 65%($ZrO_2Y_2O_3$)
Plasma current, I (A)	500	700	750
Plasma voltage, U (V)	65	60	74
Primary plasma gas flow rate Ar, l/min	50	50	50
Secondary plasma gas flow rate He [(1)], H_2[(2)], l/min	10 [(1)]	9 [(2)]	9 [(2)]
Carrier gas flow rate, l/min	--	3	3
Powder feed rate, g/min	--	40	50
Stand-off distance, mm	270	270	270
Chamber pressure, mbar	25	120	120
Nozzle diameter (mm)	8	8	8
Speed of the gun, mm /s	15	15	15

The plasma spray powder deposition parameters are shown in Table 2. The upper $ZrO_2$8wt.% Y_2O_3 ceramic layers were deposited with a thickness of 250 μm - 270 μm.

Table 2 – The parameters of the deposition of the ZrO28wt.%Y2O3 powder
Таблица 2 – Параметры напыления порошка ZrO28wt.%Y2O3
Табела 2 – Параметри депозиције праха ZrO28wt.%Y2O3

Parameters	Metco 204F
Plasma current, I (A)	900
Plasma voltage, U (V)	43
Primary plasma gas flow rate Ar , l/min	47
Secondary plasma gas flow rate He, l/min	32
Carrier gas flow rate Ar, l/min	6
Powder feed rate, g/min	50
Stand-off distance, mm	80

Results and discussion

The values of the coating system microhardness are shown in Figure 3. The bonding coating - BC (CoNiCrAlY) had microhardness values from 595 to 610$HV_{0.3}$. The measured values of the bonding coating microhardness were uniform, which indicates that a small proportion of micropores was present in the coating, also confirmed by an image analysis. The layers of the cermet coating - BC/CC ($ZrO_2Y_2O_3$35 CoNiCrAlY%) had slightly higher values of microhardness due to the content of ceramics; the values were rather uniform and in a range from 620 to 660$HV_{0.3}$.

The deposition of powder particles by the VPS process at low pressure made it possible to produce thicker layers of bonding and cermet coatings with more consistent microhardness values. The ceramic coating - CC ($ZrO_2$8% Y_2O_3) deposited by the APS process at atmospheric pressure had the highest microhardness values in a range from 690 to 760$HV_{0.3}$. Due to high melting temperature, ceramic powder particles were semi-molten in the core and, in a collision with a previously deposited layer, they were plastically deformed achieving inter-lamellar contacts followed by the formation of inter lamellar pores, which is characteristic for ceramics. Figure 3 shows the minimun and maximum microhardness values of the $ZrO_2Y_2O_3$ / $ZrO_2Y_2O_3$CoNiCrAlY / CoNiCrAlY coating system.

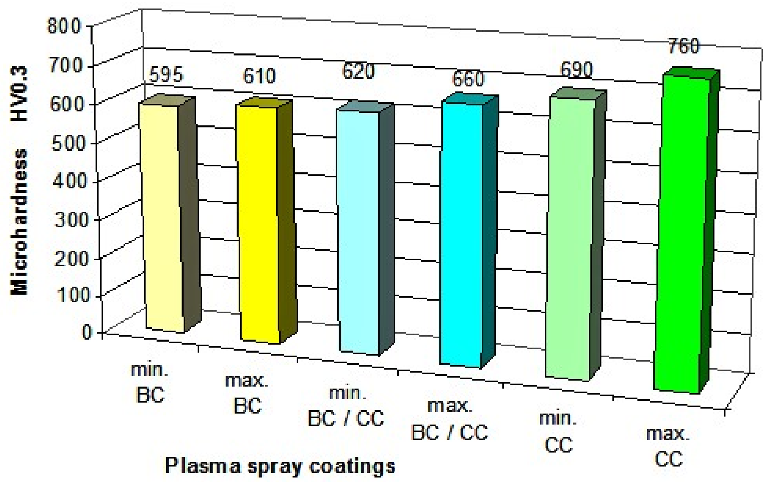

Figure 3 – Microhardness of $ZrO_2Y_2O_3$ / $ZrO_2Y_2O_3$CoNiCrAlY / CoNiCrAlY coatings
Рис. 3 – Микротвердость покрытия $ZrO_2Y_2O_3$ / $ZrO_2Y_2O_3$CoNiCrAlY / CoNiCrAlY
Слика 3 – Микротврдоћа $ZrO_2Y_2O_3$ / $ZrO_2Y_2O_3$CoNiCrAlY / CoNiCrAlY превлака

The mean value of the coating system strength was 68 MPa. The application of a transferred arc made the substrate surface clean and reactive with deposited powder particles. Powder particles deposited in vacuum achieve good contact inter-lamellar bonding as well as good bonding with the substrate. The values of microhardness and tensile strength of the coating system were in correlation with the microstructure of the deposited layers. Figures 4 and 5 show the microstructures of the coating layers.

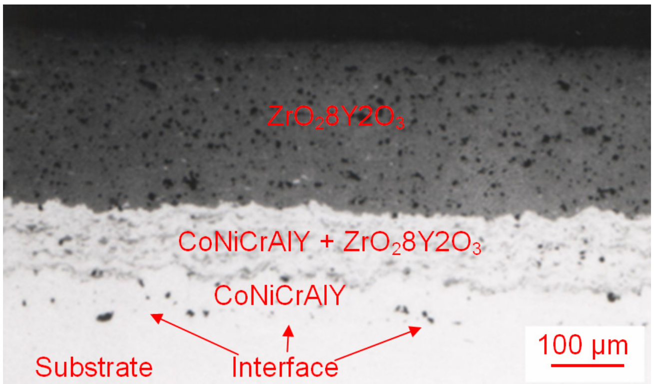

Figure 4 – The microstructure of the $ZrO_2Y_2O_3$ / $ZrO_2Y_2O_3$CoNiCrAlY / CoNiCrAlY coating
Рис. 4 – Микроструктура покрытия $ZrO_2Y_2O_3$ / $ZrO_2Y_2O_3$CoNiCrAlY / CoNiCrAlY
Слика 4 – Микроструктура превлаке $ZrO_2Y_2O_3$ / $ZrO_2Y_2O_3$CoNiCrAlY / CoNiCrAlY

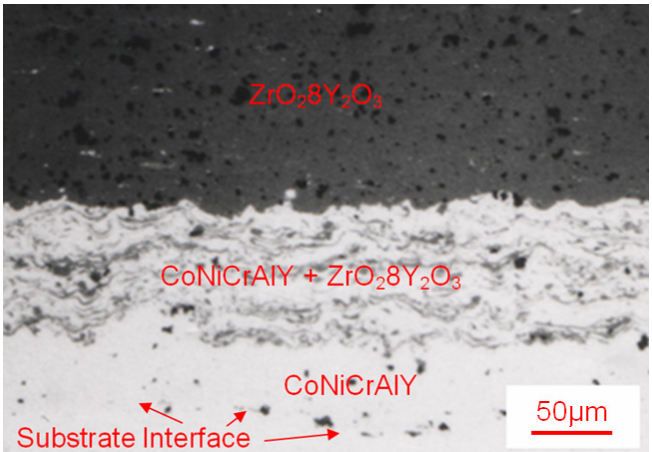

Figure 5 – The microstructure of the ZrO2Y2O3 / ZrO2Y2O3CoNiCrAlY / CoNiCrAlY coating
Рис. 5 – Микроструктура покрытия ZrO2Y2O3 / ZrO2Y2O3NiCoCrAlY / CoNiCrAlY
Слика 5 – Микроструктура превлаке ZrO2Y2O3 / ZrO2Y2O3NiCoCrAlY / CoNiCrAlY

The micrographs clearly show the interfaces between the substrates and the bonding layers, the bonding coating and the cermet coating as well as between the cermet coating and the ceramic coating. A metallographic analysis of the coatings showed that the bond between the bonding coating and the substrate is good without the presence of micro-cracks and macro cracks in the interface. The bond of the coating with the substrate is uniform without a separation and peeling of the coating from the substrate. The analysis of the micrographs showed that the share of micro pores was less than 1% in the bonding coating layers. The share of micro pores in the cermet coating layers was 2%, and in the $ZrO_2$8wt.% Y_2O_3 ceramic coating layers it was 7%. In the bonding coating layers, lamellae of deposited powder particles cannot be seen due to good melting and good interface between the deposited particles. There are no unmelted particles, precipitates and oxides in the coating since the vacuum plasma spraying process allows the deposition of layers without oxide content. Black micropores smaller than 10 µm can be seen throughout the bonding coating layers. The CoNiCrAlY coating in the deposited state comprises two phases, γ and β. The coating base consists of the γ phase which is a solid solution of Co, Ni, Cr and the β (Co,Ni)Al phase (Cheruvu, et al., 2000, pp.50-54), (Mobarra, et al., 2006, pp.2202-2207), (Mrdak, 2013, pp.26-47), (Poza, Grant, 2006, pp.2887-2896). The middle cermet inter-layer is continuously deposited on the bonding coating. Dark gray ceramic coating lamellae uniformly distributed among light gray lamellae of the bonding coating are clearly visible throughout the cermet layer (Fig.6). Black micro pores up to 10 µm can be seen in the cermet layer (Fig.5). The upper ceramic layer is deposited uniformly on the cermet layer in which black micro pores can be seen (Fig 4).

Figure 7 shows a SEM micrograph of the surface of a completely molten $ZrO_2$8wt.% Y_2O_3particle. The SEM analysis of the morphology of the surface of a deposited ceramic powder particle shows that it is smooth, indicating that it is completely molten and properly deposited on the previously deposited ceramic layer.

The surface of a completely molten $ZrO_2Y_2O_3$ particle is circled in red in the SEM micrograph. Because of complete melting, a powder particle formed a regular geometric shape when colliding with the surface. The microstructure shows fine precipitates of irregular shapes up to 10 µm, circled in yellow. The SEM micrograph clearly shows fine black micro pores, irregularly shaped, up to 5 µm in size (circled in green).

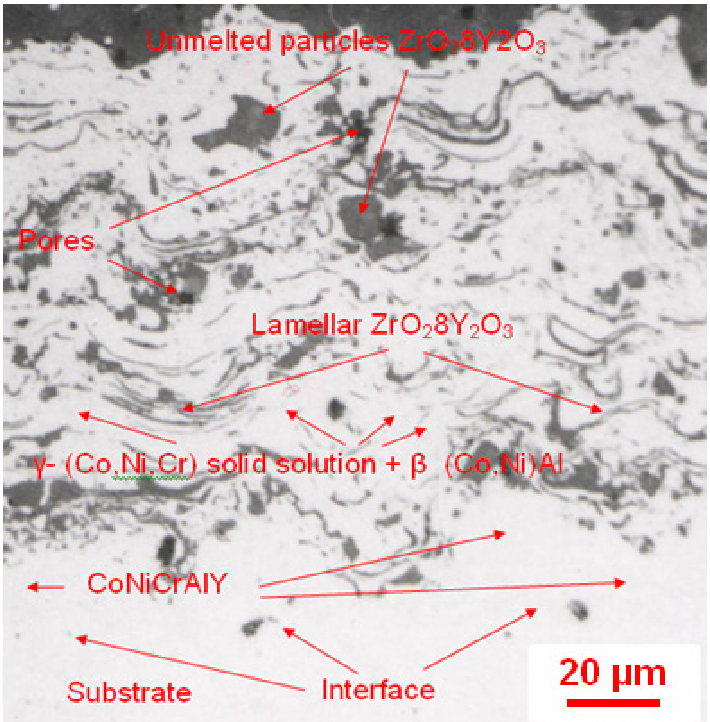

Figure 6 – The VPS microstructure of the CoNiCrAlY + $ZrO_2Y_2O_3$ coating
Рис. 6 – Микроструктура покрытия VPS CoNiCrAlY + $ZrO_2Y_2O_3$
Слика 6 – Микроструктура VPS CoNiCrAlY + $ZrO_2Y_2O_3$ превлаке

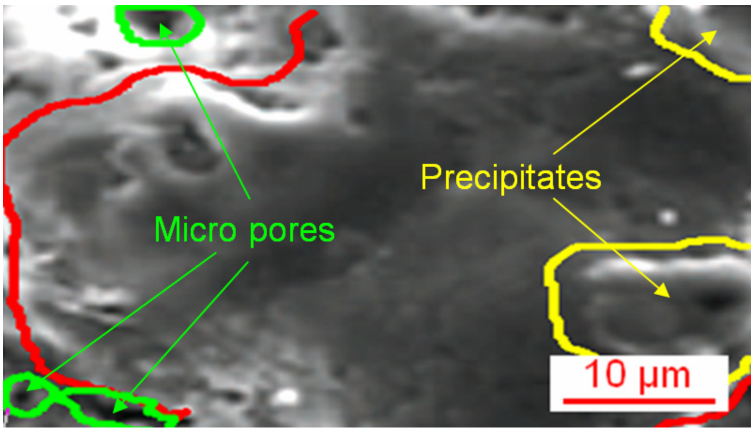

Figure 7 – (SEM) Surface morphology of the $ZrO_2Y_2O_3$ coating
Рис. 7 – (SEM) Морфология поверхности покрытия $ZrO_2Y_2O_3$
Слика 7 – (SEM) Морфологија површине $ZrO_2Y_2O_3$ превлаке

Conclusion

In this study, the plasma spray process produced a coating system of $ZrO_2Y_2O_3$ / $ZrO_2Y_2O_3$CoNiCrAlY / CoNiCrAlY. The bonding coating and the cermet coating were deposited by the vacuum plasma spray process. The upper functional $ZrO_2Y_2O_3$ ceramic coating was deposited by the atmospheric plasma spray process. The paper analyzes the structure and the mechanical properties of the coatings in the deposited state, based on which the following conclusions were made.

The coating system had good mechanical properties with the following microhardness values: the bonding layer from 595 to 610$HV_{0.3}$, the transitional cermet layer from 620 to 660$HV_{0.3}$ and the upper ceramic layer from 690 to 760$HV_{0.3}$. The bonding and cermet coatings had a quite uniform microhardness, allowed by the VPS process at low pressure. The $ZrO_2$8% Y_2O_3 ceramic coating deposited by the APS process at atmospheric pressure had the highest microhardness value with a range of 70$HV_{0.3}$. The bond strength of the coating system had a high value of 68MPa. The application of the transferred arc provided a good adhesive bond of molten particles with the substrate and a good cohesive bond between deposited lamellae.

The analysis of the micrographs showed that the share of pores in the bonding coating was less than 1%, in the layers of the cermet coating it was 2%, and in the $ZrO_2$8wt.% Y_2O_3 ceramic coating it was 7%. The microstructure of the bonding coating shows a lamellar structure due to good melting of powder particles and a good interface of deposited particles. The middle cermet layer is continuously deposited on the bonding coatings. Dark gray lamellae of the ceramic coating are clearly visible throughout the cermet coating as well as micropores in black.

The $ZrO_2Y_2O_3$ ceramic layer is evenly deposited on the cermet layer. In the $ZrO_2Y_2O_3$ ceramic coating and on the surface there are no defects such as coarse unmelted particles, coarse pores, micro cracks and macro cracks and other defects which have a negative effect on the mechanical properties and functionality of the coating. The surface of the $ZrO_2Y_2O_3$ coating shows that powder particles are regularly deformed and smooth and as such are suitable for the application in biomedicine.

Based on the obtained mechanical and structural characteristics of the $ZrO_2Y_2O_3$ coating, it was found that the quality of the coating makes it suitable for use with other materials in creating a system of biomedical coatings.

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МЕХАНИЧЕСКИЕ ХАРАКТЕРИСТИКИ И МИКРОСТРУКТУРА ПОКРЫТИЙ $ZrO_2Y_2O_3$ / $ZrO_2Y_2O_3$CoNiCrAlY / CoNiCrAlY, НАНЕСЕННЫХ ВОЗДУШНО-ПЛАЗМЕННЫМ НАПЫЛЕНИЕМ

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ОБЛАСТЬ: химические технологии
ВИД СТАТЬИ: оригинальная научная статья
ЯЗЫК СТАТЬИ: английский

Резюме:

Керамика ZrO_2 стабилизированная оксидом иттрия Y_2O_3 обладает наилучшими характеристиками по сравнению с иными современными керамическими материалами. Благодаря высокому проценту биосовместимости, керамика ZrO_2 в системе ZrO_2-Y_2O_3 широко применяется в качестве биоматериалов в ортопедической хирургии. Керамика ZrO_2 используется в области протезирования, в частности, для изготовления головки бедренной кости, колени, временного протеза и пр. В области медицины ZrO_2 широко используется в изготовлении протеза бедра (THR), коленного сустава, и иных медицинских аппаратов. Нанесение керамического покрытия $ZrO_2Y_2O_3$(YSZ) на биомедицинские субстраты должно быть равномерным, а его слои без изъянов. Для нанесения керамического покрытия $ZrO_2Y_2O_3$(YSZ), обладающего наилучшими структурными характеристиками была испытана система покрытий $ZrO_2Y_2O_3/ZrO_2Y_2O_3CoNiCrAlY/CoNiCrAlY$. В целях экономии, напыление выполнено на стальном субстрате связывающим покрытием CoNiCrAlY, не влияющим на структуру и функциональность керамического слоя $ZrO_2Y_2O_3$. Структура слоев испытана методом оптической микроскопии, а поверхность ZrO28mas%Y2O3 испытана методом электронной микрографии (SEM). На основании полученных характеристик установлено, что содержание порообразований в керамическом слое достаточно низкое, а микропоры равномерно распределены. Анализ механических характеристик покрытия проведен на основании испытаний микротвердости методом $HV_{0.3}$ и прочности соединений методом растяжения. Значения микротвердости $ZrO_28mas\%Y_2O_3$ покрытия соответствуют требованиям, так же как и прочность связи покрытий.

Ключевые слова: *ZrO_2, Y_2O_3, свойства, микроструктура, механические характеристики, слои, покрытие, керамика, соединения.*

МЕХАНИЧКЕ ОСОБИНЕ И МИКРОСТРУКТУРА ПЛАЗМА НАПРСКАНЕ ПРЕВЛАКЕ $ZrO_2Y_2O_3$ / $ZrO_2Y_2O_3CoNiCrAlY$ / CoNiCrAlY

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Сажетак:

Керамика ZrO_2, стабилизована са Y_2O_3, има супериорна и одлична физичка својства у поређењу са другим савременим керамичким материјалима. Због високе биокомпатибилности она у систему ZrO_2-Y_2O_3 има широку примену као биоматеријал у ортопедској хирургији. Керамика ZrO_2-Y_2O_3 најчешће се примењује за израду глава кука, протеза колена, привремених држача итд. ZrO_2 је у клиничкој употреби као укупна замена кука (THR), у зглобу вештачких колена, али се користи за примену и развој других медицинских уређаја. Да би се керамика $ZrO_2Y_2O_3$(YSZ) користила на биомедицинским субстратима, неопходно је депоновати слојеве превлаке без дефеката. Ради депозиције керамичке превлаке $ZrO_28теж\%Y_2O_3$ са најбољим структурним својствима, испитан је систем превлака $ZrO_2Y_2O_3/ZrO_2Y_2O_3CoNiCrAlY/CoNiCrAlY$. Због економичности депозиција је извршена на челичном супстрату уз примену везне превлаке CoNiCrAlY, што не утиче на структуру и *функционалност керамичког слоја $ZrO_2Y_2O_3$. Структура слојева испитана је методом светлосне микроскопије, а површина горње керамичке превлаке $ZrO_2$8мас%Y_2O_3 методом скенинг електронске микроскопије (SEM). На основу добијених карактеристика утврђено је да садржај порозности у керамичком слоју није био висок и да су микропоре равномерно распоређене. Процена механичких особина слојева урађена је испитивањем микротврдоће методом $HV_{0.3}$ и затезне чврстоће споја испитивањем на затезање. Вредности микротврдоће $ZrO_2$8мас%Y_2O_3 превлаке биле су задовољавајуће и затезна чврстоћа споја система превлака.*

Кључне речи: *ZrO_2, Y_2O_3, својство, микроструктуре, механичка својства, слојеви, превлаке, керамике, везивање.*

Paper received on / Дата получения работы / Датум пријема чланка: 28. 03. 2016.
Manuscript corrections submitted on / Дата получения исправленной версии работы / Датум достављања исправки рукописа: 02. 04. 2016.
Paper accepted for publishing on / Дата окончательного согласования работы / Датум коначног прихватања чланка за објављивање: 04. 04. 2016.