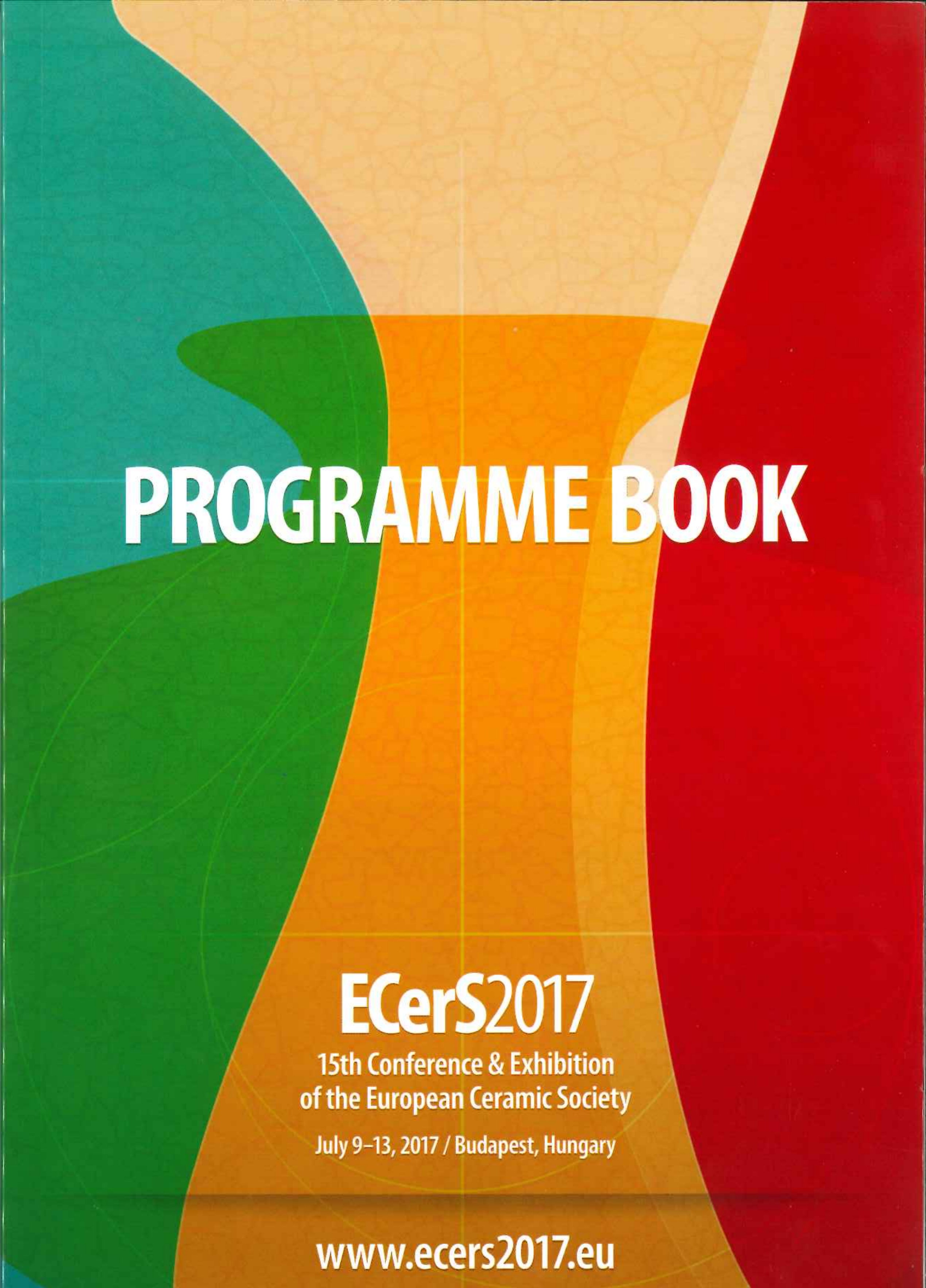

PROGRAMME BOOK

ECerS2017

15th Conference & Exhibition of the European Ceramic Society

July 9–13, 2017 / Budapest, Hungary

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ECerS2017

July 9–13, 2017, Budapest, Hungary

Jointly organised by the
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partially melted matrix of Al_2O_3/Y-TZP, confirming that the SiC particles have not been oxidised during plasma spraying, preserving its potential self-healing ability. Besides, the effect of stand-of distances on the coatings porosity and adherence was also assessed.

Acknowledgements
This work has been supported by the Spanish Ministry of Economy and Competitiveness (ref. MAT2015-67586-C3-R).

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Adhesion assessment of bioactive coatings deposited by atmospheric plasma spraying

Eugeni Cañas[*], *Mónica Vicent, M^a José Orts, Enrique Sánchez*

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Keywords: bioactive powders, atmospheric plasma spraying, bioactive coatings, coatings adhesion

Bioactive coatings are used in the field of medicine as coatings for orthopaedic implants made of bio-inert materials such as stainless steel, chromium/cobalt or titanium alloys with the aim of conferring biocompatibility and protecting them against the corrosion and the degradation promoted by biological fluids. Usually, these coatings can be deposited by different techniques such as enamelling, sol-gel or dipping. However, atmospheric plasma spraying (APS) is one of the most studied and used method for obtaining these coatings. While bioactive coatings have to accomplish several requirements (biocompatibility, porosity, rough surface, etc.), a good adhesion to the implant surface represents one of the most important challenges which is hardly reached.

Therefore, the aim of the present work is to prepare bioactive coatings by APS employing different spraying parameters and substrates in order to model the adhesion of the coatings and to determine the best parameters that allow to prepare coatings with good adhesion to the substrate. For that purpose, a statistical analysis was performed evaluating the adhesion in function of different variables, each one at two different levels, and correlating the adhesion with them. The variables chosen are the argon flow and the feedstock feed rates, the type of substrate and the presence of a bond coat. Furthermore, coatings were microstructurally characterised by scanning electron microscopy and their nature (amorphous or crystalline) was determined by X-ray diffraction.

The obtained results show significant differences in coatings adhesion in function of the variables tested, varying this mechanical property from 0.6 to 10 MPa. Moreover, the model and the correlations between variables obtained from the statistical analysis, confirm that the adhesion is strongly influenced by the presence of a bond coat as well as the plasma gases flow rate and the type of substrate. Besides, it can be appreciated that coatings with higher adhesion values show better microstructures.

Acknowledgements
This work has been supported by Research Promotion Plan of the Universitat Jaume I (ref. PREDOC/2015/50).

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Creep behaviour of alumina reinforced composites sintered by spark plasma sintering

Rafael Cano-Crespo[1*], *Bibi Malmal-Moshtaghioun*[1], *Diego Gómez-García*[1,2],
Arturo Domínguez-Rodríguez[1], *Rodrigo Moreno-Botella*[3]

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Keywords: graphene-oxide, carbon nanofiber, alumina composites, creep resistance

Alumina (Al_2O_3) ceramic composites reinforced with either graphene oxide (GO) or carbon nanofibers (CNFs) were prepared using Spark Plasma Sintering. The effects of GO and CNFs on the microstructure and in consequence, on their mechanical properties, were investigated. The microstructure of the sintered materials have been characterized quantitatively prior to and after the creep experiments in order to determine the deformation mechanism.

Carbon materials, such as carbon fibers or carbon nanotubes (CNTs), or graphene, have been used in the last decades to improve the mechanical properties of a large variety of materials. Another way to improve the mechanical properties of alumina is by means of fibers as reinforcement in ceramic composites. Fiber/whiskers usually have diameters ranged from a micrometer to tens of micrometers and lengths from several micrometers till hundreds of micrometers, embedded inside a fine-grained ceramic matrix.[1]

The study of their plasticity can permit to go insight the intrinsic mechanisms of matter flow and phase arrangement under loading conditions. This basic information is crucial to feedback and improve the processing conditions for an optimized composite.

High-temperature creep behavior of graphene-oxide reinforced alumina composites and carbon nanofiber reinforced ones prepared by spark plasma sintering have been studied at temperatures as high as 1200 ºC and above. The results show that the microstructure is quite stable during creep and consistent with grain boundary sliding as the deformation mechanism. The graphene-oxide-reinforced alumina composite is systematically more creep resistant than the carbon nanofiber one, although the creep resistance diminishes when temperature increases. In this context, graphene oxide and carbon nanofibers offer similar advantages in very high-temperature applications of alumina composites.

Reference

1. B.R. Lawn. Fracture of brittle solids. 2nd ed. Cambridge, Cambridge University Press, 1990.

ADHESION ASSESSMENT OF BIOACTIVE COATINGS DEPOSITED BY ATMOSPHERIC PLASMA SPRAYING

EUGENI CAÑAS, MÓNICA VICENT, MARÍA JOSÉ ORTS, ENRIQUE SÁNCHEZ

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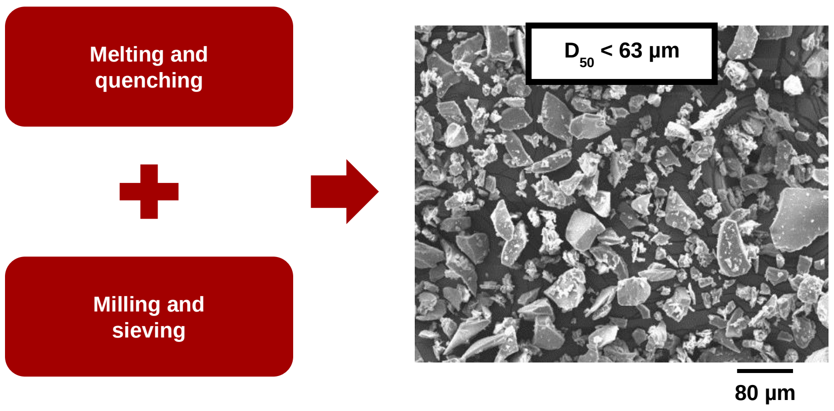
1. Introduction

Bioactive coatings can be deposited by different techniques such as enamelling, sol-gel or dipping. However, atmospheric plasma spraying (APS) is one of the most studied and used method to obtain these coatings. While bioactive coatings must accomplish several requirements (biocompatibility, porosity, rough surface, etc.), a good adhesion to the substrate surface is one of the most important challenge.

For that reason, the objectives of this work are the deposition of bioactive glass coatings by APS and the modelling of their adhesion strength by a statistical analysis (2^k full factorial design), in order to determine the best experimental conditions for maximising coatings adhesion strength.

2. Experimental

2.1. Feedstock preparation and characterisation


Melting and quenching

Milling and sieving

Figure 1. Route for obtaining the glass powder and SEM micrograph of the particles

Table 1. Composition of the obtained glass powder

Composition (wt%)	SiO_2	P_2O_5	CaO	Na_2O
Nominal (45S5)	45.0	6.0	24.5	24.5
As-melted	47.6	5.3	23.1	24.0

2.2. Coatings deposition

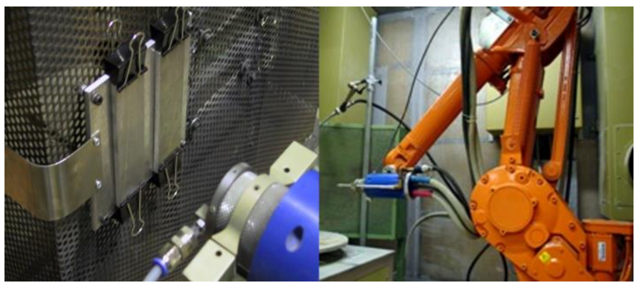


Figure 2. Plasma torch F4-MB (Oerlikon-Metco, Switzerland)

Table 2. Design of experiments: plasma spraying parameters range

Variables	Argon flow rate (A)	Glass flow rate (B)	Substrate (C)	Bond coat (D)
Lowest level	38 slpm[a]	15 g/min	AISI 304	Without
Highest level	25 slpm[a]	20 g/min	Ti6Al4V	With

[a] *Standard litres per minute*

Table 3. Plasma spraying parameters used for coatings deposition

Spraying parameters	Bond coat (TiO_2)	Bioactive coating
Argon flow rate (slpm)	38	(Table 2)
Hydrogen flow rate (slpm)	14	14
Current (A)	600	600
Torch velocity (m/s)	1	1
Stand-off distance (m)·10^3	120	110

2.3. Determination of coatings adhesion strength

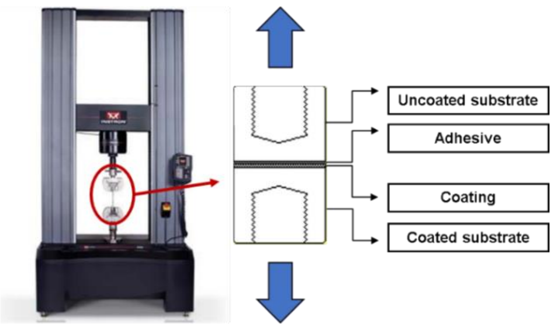


Figure 3. Device employed for measuring coatings adhesion strength according to ASTM-C633

3. Results

3.1. Coatings adhesion strength

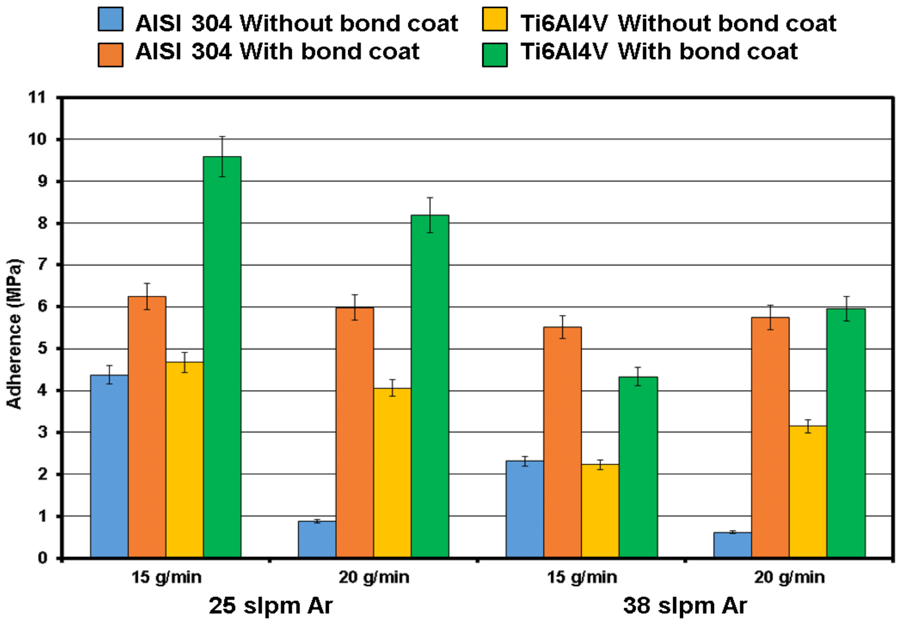


Figure 4. Adhesion strength results

3.2. Coatings characterisation

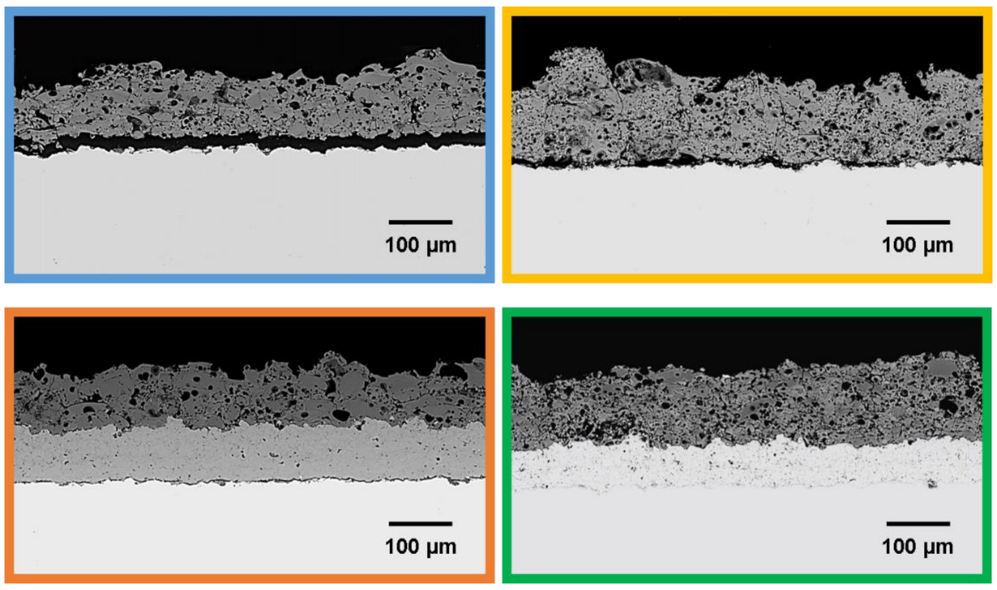


Figure 5. SEM micrographs of the coatings deposited using 25 slpm of Ar and 15 g/min of powder

3.3. Modelling of coatings adhesion strength

Table 4. Correlation and significance of each variable tested and their interactions for a confidence level of 95%

Variables	Correlation with adhesion	Significance in adhesion
A (Argon flow rate)	0,377	99 %
B (Glass flow rate)	-0,119	76 %
C (Substrate)	0,277	96 %
D (Bond coat)	0,772	100 %
Interactions	Correlation with adhesion	Significance in adhesion
AB	-0,187	87 %
AC	0,198	90 %
AD	0,071	51 %
BC	0,155	82 %
BD	0,134	77 %
CD	-0,040	27 %

- **Proposed model:**

$$\boxed{\textit{Adhesion (MPa)} = 4.62 + 0.88A + 0.66C + 1.83D \quad \text{(Eq. 1)}}$$

4. Conclusions

- A bioactive glass powder was obtained with particle size less than 63 µm and a composition close to the 45S5 glass
- After coatings deposition, it can be appreciated a relation between coatings adhesion and the presence of a bond coat, the type of substrate and the torch enthalpy
- For each type of substrate, the best adhesion value was obtained under the presence of a bond coat, high torch enthalpy and low powder flow rate

5. References

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More information

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