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Chemical analysis on laser processed Ultrahydrophobic Ti-6Al-4V surface by high vacuum Process

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ABSTRACT

A technique has been developed for fabrication of ultrahydrophobic Ti-6Al-4V surface by vacuum process. This report has the data related to the article “Hybrid laser and vacuum process for rapid ultrahydrophobic Ti-6Al-4V surface formation” on the fabrication of ultrahydrophobic Ti-6Al-4V by Vacuum process (Jagdheesh et al., 2019). The present data consist of X-ray photo electron spectroscopy spectrums recorded for the laser patterned ultrahydrophobic samples, droplet image and surface chemical composition of laser patterned Ti-6Al-4V samples before vacuum process (b. v. p.) and after vacuum process (a. v. p.) for 120 min. The presented data give a clear idea about the chemical modification evolved during the vacuum process.

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Specifications table

Subject area	Physics, chemistry, material science,
More specific subject area	Chemical analysis and wetting properties
Type of data	Table, image and X-ray spectrums

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How data were acquired	X-ray photoelectron spectroscopy (Thermo Scientific K-Alpha X-ray Photoelectron Spectrometer (XPS) system) with an acceleration voltage of 150 eV for survey scan and 50 eV for high resolution scans
Data format	<i>Raw & Analyzed</i>
Experimental factors	<i>No special treatments were carried out.</i>
Experimental features	A novel technique of post-vacuum processing the laser patterned surface was used for high speed fabrication of Ultrahydrophobic Ti6Al4V. The hydrophobicity of the laser patterned dual geometry structures transforms to ultrahydrophobic in 120 min of vacuum process without any chemical treatments to suppress the surface polarity.
Data source location	<i>Centro Láser, Universidad Politécnica de Madrid, Ctra. de Valencia, Km, 7.3, 28031, Madrid, Spain.</i>
Data accessibility	<i>With this article</i>
Related research article	Hybrid laser and vacuum process for rapid ultrahydrophobic Ti-6Al-4V surface formation. Applied Surface Science Volume 471, 31 March 2019, Pages 759–766 https://doi.org/10.1016/j.apsusc.2018.12.047

Value of the data

- The present data provide the details about the elemental analysis on the vacuum processed laser patterned metal surface.
- The droplet image gives an insight to the air trapped between the liquid and solid surface.
- The XPS spectrum and the elemental concentration give an overall information about the significance of the vacuum process).

1. Data

The present data corresponds to X-ray photo electron spectroscopy (XPS) performed on the vacuum processed [2] ultrahydrophobic [3] laser patterned samples (Figs. 1–5). The laser patterning experiments were performed for different spatial shifts for 2D scanning and the spatial shifts are termed as hatch distance (HD). The intensity of XP spectra has been normalized by the maximum intensity of O 1s peak. Table 1 gives the details about the elemental concentration whereas Table 2 gives the details about the durability of the vacuum processed surface against wetting effect. Fig. 6 represents water droplets on the laser-patterned surface and Fig. 7 corresponds to schematic representation of condensation reaction of carboxylic acids on TiO₂ hydroxylated surface.

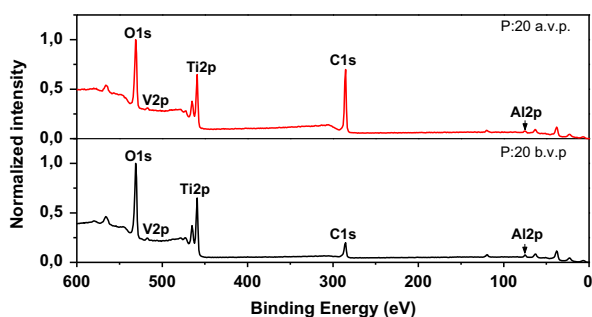


Fig. 1. XPS surveys of μ -cell fabricated samples with P: 20 μ m before and after vacuum process for 120 min.

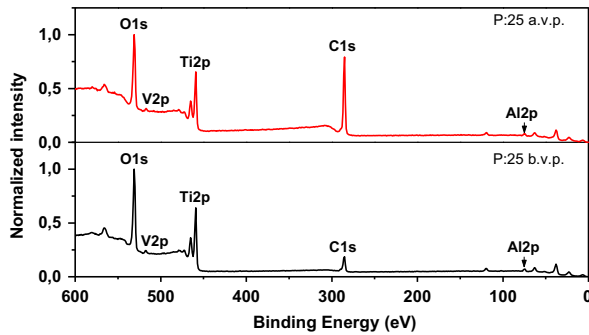


Fig. 2. XPS surveys of μ -cell fabricated samples with P: 25 μm before and after vacuum process for 120 min.

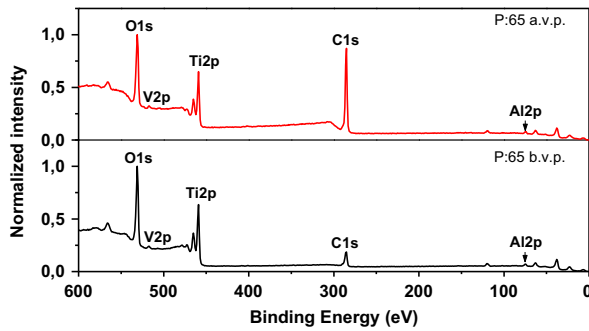


Fig. 3. XPS surveys of μ -cell fabricated samples with P: 30 μm before and after vacuum process for 120 min.

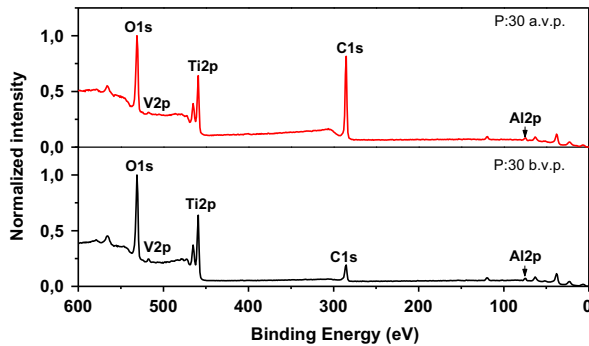


Fig. 4. XPS surveys of μ -cell fabricated samples with P: 45 μm before and after vacuum process for 120 min.

2. Experimental design, materials and methods

The laser patterned Ti-6Al-4V samples were stored in vacuum chamber [1] for the transformation of wetting properties. The robust alteration in the surface chemistry on the top surface laser patterned microstructure has been studied by X-ray photo electron spectroscopy (XPS). XPS profile were recorded by Thermo Scientific K-Alpha radiation by an acceleration voltage of 150 eV for survey scan and 50 eV for high-resolution scans. Different samples with respect to P has been analyzed. The time-

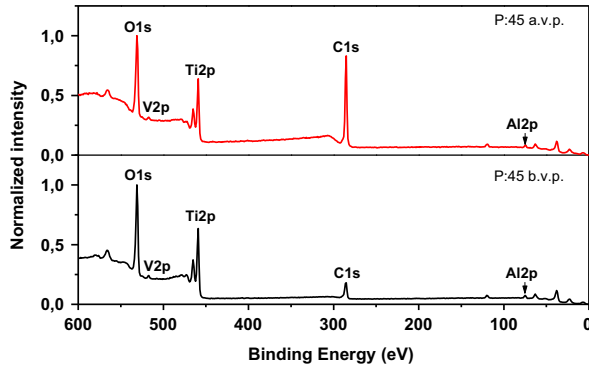


Fig. 5. XPS surveys of μ -cell fabricated samples with P: 65 μm before and after vacuum process for 120 min.

Table 1

Surface chemical composition of laser patterned Ti-6Al-4V samples before (b. v. p.) and after (a. v. p.) 120 min of vacuum process.

Sample "P"	C (At%)	O (At%)	Ti (At%)	V (At%)	Al (At%)
P:20 μm -Pillar (b. v. p.)	27.37	49.18	15.26	0.74	7.44
P:20 μm -Pillar (a. v. p.)	59.18	27.26	8.11	0.52	3.24
P:20 μm -channels (b. v. p.)	27.98	48.92	15.2	0.62	7.29
P:20 μm -channels (a. v. p.)	59.18	28.67	8.49	0.44	3.12
P:25 μm -Pillar (b. v. p.)	27.28	50.11	15.6	0.87	6.07
P:25 μm -Pillar (a. v. p.)	61.03	26.48	8.12	0.47	3.91
P:25 μm -channels (b. v. p.)	18.02	52.02	15.36	0.57	6.22
P:25 μm -channels (a. v. p.)	62.51	25.87	7.69	0.56	3.36
P:30 μm -Pillar (b. v. p.)	27.59	49.97	15.08	0.82	6.55
P:30 μm -Pillar (a. v. p.)	61.91	26.02	7.93	0.36	3.6
P:30 μm -line (b. v. p.)	27.5	50.36	15.28	0.67	6.2
P:30 μm -line (a. v. p.)	62.42	26.68	7.67	0.43	7.67
P:35 μm -Pillar (b. v. p.)	27.10	50.45	15.88	0.85	5.72
P:35 μm -Pillar (a. v. p.)	61.94	26.43	7.53	0.45	3.64
P:35 μm -Channel (b. v. p.)	25.27	51.77	16.42	0.93	5.61
P:35 μm -Channel (a. v. p.)	60.43	27.7	8.21	0.47	3.19
P:45 μm -Pillar (b. v. p.)	27.33	49.91	15.93	0.72	6.11
P:45 μm -Pillar (a. v. p.)	62.64	26.46	7.53	0.41	2.96
P:45 μm -Channel (b. v. p.)	26.33	51.28	16.27	0.81	5.31
P:45 μm -Channel (a. v. p.)	62.86	25.65	7.69	0.54	3.25
P:65 μm -Pillar (b. v. p.)	49.95	30.3	14.91	0.76	4.77
P:45 μm -Pillar (a. v. p.)	64.94	25.51	7.02	0.36	2.83
P:65 μm -Channel (b. v. p.)	30.30	49.25	14.91	0.764	4.77
P:65 μm -Channel (a. v. p.)	63.94	25.42	7.35	0.28	3.01

Table 2

Wetting property measurement for sample vacuum processed for 120 minutes and 30 minutes for all P values.

Days	Samples stored for 30 min in high vacuum CA ($^\circ$)	Samples stored for 120 min in high vacuum CA ($^\circ$)
15	152	180
30	154	180
45	152	180
60	156	180
120	153	180
160	155	180
200	156	180

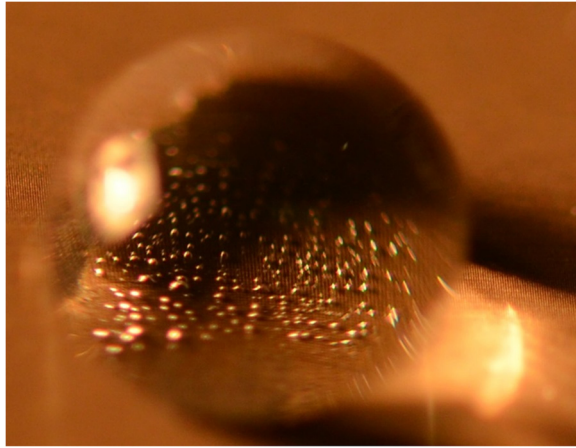


Fig. 6. Water droplet on the laser patterned region with air bubbles at the mouth of the μ -cell structure creating solid-liquid interface.

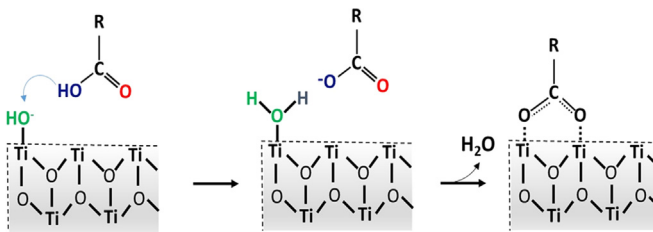


Fig. 7. Schematic representation of condensation reaction of carboxylic acids on TiO_2 hydroxylated surface, yielding a carboxylate adsorbed on two Ti_{5f} in bridged bidentate coordination.

to-time measurement of static contact angle has been performed to verify the consistency of the wetting properties. The elemental concentration measure is presented in [Table 1](#).

2.1. Durability and consistency

[Table 2](#) portrays the wetting property measured periodically up to 200 days to verify the consistency and durability of the vacuum processed samples. The static contact angle (SCA) measurements were measured with droplet volume ranging from 8 to 20 μL . Primarily, the samples vacuum processed with 30 min. showed CA value in range of 40–50°, which has been increased to 154°. This is due to aging process, which has been well proven phenomena. All the samples irrespective of the P value shows a consistency and durability of wetting properties with respect to time. Therefore, it is well proven that, the transformation of wetting property is permanent as long as the samples are physically manipulated (eg. plasma cleaning or breaking the rounded edge).

Transparency document. Supporting information

Transparency document associated with this article can be found in the online version at <https://doi.org/10.1016/j.dib.2019.01.015>.

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- [1] R. Jagdheesh, M. Diaz, S. Marimuthu, J.L. Ocaña, Hybrid laser and vacuum process for rapid ultrahydrophobic Ti-6Al-4V surface formation, *Appl. Surf. Sci.* 471 (2019) 759–766.
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