

SURFACE METROLOGY OF CERAMIC TILES BY USING A NON CONVENTIONAL TECHNIQUE

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1. INTRODUCTION

Surface topography plays an important role in understanding the nature of a ceramic tile surface.

To measure the surface parameters, there are a large number of different types of instruments. Generally, the measurement techniques can be divided into two categories: (a) contact types and (b) non-contact types. Contact type stylus profilers are the most popular but, more recently, non-contact profilers based upon using spectral shifts and interferences in light reflection by sensors or microscopes, have been developed and are now widely used.

In recent years, the availability of this new generation of measuring instruments has promoted qualitative and quantitative characterisation of surface texture, not only for advanced ceramics but also for traditional ceramics.

Usually ceramic tile surfaces are analysed by using stylus 2D profilers, but quite often, 2D measurements are not always enough to describe a surface.

The present work deals with the study of surface metrology of commercial ceramic tiles by using a non-conventional technique, an optical 3D profiler (interferometer, Talysurf CCI, Taylor Hobson, UK, objective 50X). The obtained results are compared with those of a stylus 2D profiler (Hommel Tester, T2000, D, TKL 300 or TKL 100 pick-ups).

2. EXPERIMENTAL

Line profiles (2D) were made by both the profilers, optical and stylus, while surface profiles (3D) were made only by the optical profiler.

Because the standard for 3D measurement is still in progress (ISO 25178) [1], in the present work, for the 3D analyses, a procedure has been set up that is compatible, as much as possible, with Standard EN 623-4 [2], even if it is related to conventional stylus type instruments for the 2D texture measurement of advanced monolithic technical ceramics surfaces.

Four commercial ceramic tiles were selected for the study. Two samples are porcelain stoneware tiles, as fired and polished, and the others are glazed, glossy and matt. In accordance with standard ENV 623-4, 10 measurements of 4 mm length were collected for each sample with both the stylus 2D profiler and the optical 3D profiler, by using a cut-off filter of 0.8 mm to evaluate the roughness parameters. For the 3D measurements, areas of 5x1 mm were collected for each sample.

3. RESULTS AND DISCUSSION

The 2D parameters adopted to compare the techniques were those described in Standard ISO 4287 [3], both for the primary profile, before applying the filter (Pz, Pv, Pa and Pq) and for the roughness profile (Rz, Rv, Ra and Rq). The 3D parameters adopted to analyse the sample surfaces were those described in Standard ISO 25478-2 (Sz, Sa and Sq). In Table I these parameters, collected with both the profilers, optical and stylus, are reported for each sample.

The results of the 2D parameters, both for the primary and for the roughness profile, shows that for all the samples the differences among the two techniques (optical and stylus) are not significant, considering the standard deviation. Only in the polished porcelain stoneware sample, it seems that, with the stylus profiler, Pv (Maximum Valley Depth of the raw profile) is higher than that obtained with the optical profiler. It could be due to the local tilt angle in valleys (pores): it is well known that rapid changes in slope can be difficult to measure by using an interferometric technique [4]. The differences between the two surfaces, as fired and polished, are appreciable. In particular, Pa (Arithmetic Mean Deviation of the raw profile), Ra (Arithmetic Mean Deviation of the roughness profile) and Sa (Arithmetic mean height) are significantly lower in the polished surface. For the glossy and matt glazes, all the 2D and 3D parameters are similar, even if by observing the 3D images (about 300x300 μm) in Figure 1, the differences in the surface finish are appreciable.

As-fired tile		Polished tile		Glossy glaze		Matt glaze	
optical	stylus	optical	stylus	optical	stylus	optical	stylus
Pz, μm	18.69 \pm 2.26	18.44 \pm 3.26	2.89 \pm 0.70	4.63 \pm 1.27	10.85 \pm 2.53	10.09 \pm 2.02	12.14 \pm 4.60
Pv, μm	10.63 \pm 1.81	11.37 \pm 2.30	2.30 \pm 0.62	4.28 \pm 1.30	5.74 \pm 1.81	5.52 \pm 1.58	6.02 \pm 1.63
Pa, μm	2.70 \pm 0.28	2.16 \pm 0.49	0.30 \pm 0.08	0.16 \pm 0.10	2.08 \pm 0.55	1.57 \pm 0.26	2.22 \pm 0.96
Pq, μm	3.52 \pm 0.37	2.80 \pm 0.59	0.42 \pm 0.13	0.35 \pm 0.14	2.52 \pm 0.65	1.96 \pm 0.29	2.67 \pm 1.13
Rz, μm	9.55 \pm 0.96	8.41 \pm 1.66	1.59 \pm 0.48	2.20 \pm 0.59	3.06 \pm 0.41	3.23 \pm 0.68	3.31 \pm 0.23
Rv, μm	5.90 \pm 0.87	5.19 \pm 1.40	1.30 \pm 0.39	2.00 \pm 0.55	1.92 \pm 0.28	1.86 \pm 0.54	2.01 \pm 0.14
Ra, μm	1.72 \pm 0.16	1.26 \pm 0.21	0.18 \pm 0.05	0.12 \pm 0.03	0.60 \pm 0.09	0.62 \pm 0.11	0.64 \pm 0.04
Rq, μm	2.21 \pm 0.21	1.63 \pm 0.29	0.30 \pm 0.09	0.25 \pm 0.08	0.76 \pm 0.11	0.80 \pm 0.15	0.80 \pm 0.04
Sz, μm	21.56	-	2.18	-	6.65	-	4.96
Sa, μm	1.13	-	0.08	-	0.30	-	0.46
Sq, μm	1.62	-	0.14	-	0.45	-	0.58

Table I – Results of the analyses: 2D parameters for the primary profile and roughness profile (optical and stylus profilers) and 3D parameters (optical profiler).

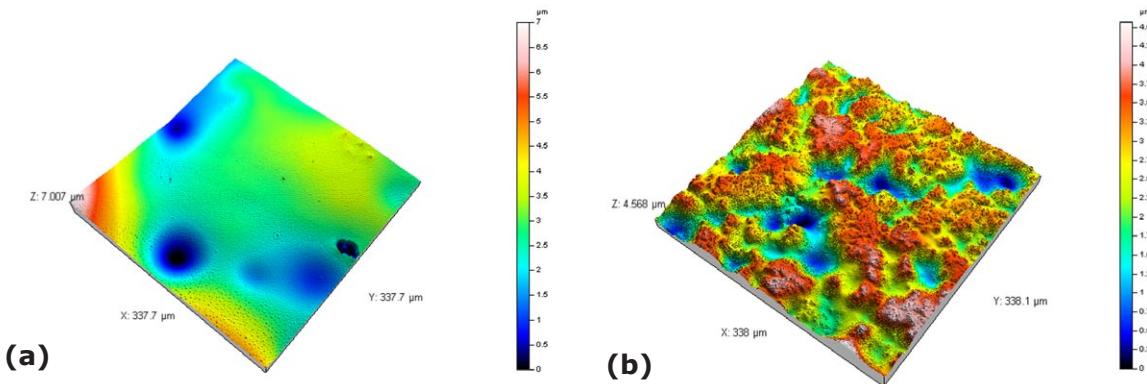


Figure 1 – 3D images of the two glazes, glossy (a) and matt (b).

4. CONCLUSION

The results show that the adopted analysis procedure, according to the specific standard for contact-type stylus profilers, can be applied to obtain valid results also by using the optical profiler. Moreover, for the typology of traditional ceramic tiles investigated, the proposed characterisation method through an optical 3D profiler is able to describe some important topographic features, which were not revealed by the 2D profiler.

REFERENCES

- [1] ISO 25178, Geometrical product specifications (GPS) - Surface texture: Areal, 2010.
- [2] ENV 623-4, Advanced technical ceramics - Monolithic ceramics- General and textural properties - Part 4: Determination of surface roughness, 2004.
- [3] ISO 4287, Geometrical Product Specifications (GPS) - Surface texture: Profile method - Terms, definitions and surface texture parameters, 2009.
- [4] I. Lindseth, A. Bardal, Quantitative topography measurements of rolled aluminium surfaces by atomic force microscopy and optical methods. Surface and coating technology, 111, 1999.