CHEMICAL DURABILITY OF CERAMIC TILE SURFACES IN ACID ENVIRONMENT

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1. INTRODUCTION

The chemical resistance of the working surface of ceramic tiles represents an important feature for their quality and appropriate service life. To understand this, it is important to determine the chemical resistance, as it is reported in the standard EN ISO 10545-13[1]. However, the standard provides a classification based only on every effects caused by the contact of the tile working surface with the established chemical solutions. The test results do not provide any information about possible damage induced on the tile surface. To acquire such information, a viable testing method could be the microstructural observation of the surfaces, before and after leaching, and the chemical analysis of the leached solutions, to evaluate the presence of the elements released by the samples. This method takes into consideration the role played by the microstructure and content in glassy and crystalline phases on the leaching mechanisms.

2. EXPERIMENTAL

In the present work, six glazed ceramic tiles were considered in order to define the role played by the glassy and crystalline phases on the leaching mechanisms. In particular three glazes (A, B and C) are highly crystalline and the other three (D, E and F) are low crystalline or amorphous. The tile working surfaces were subjected to chemical etching by using a strong acid solution (HCl, 18%), according to standard EN ISO 10545-13. Before and after the chemical etching, the tile surfaces were analysed from the microstructural and chemical point of view, by SEM-EDS. The leached solutions were analysed by ICP-OES.

3. RESULTS AND DISCUSSION

The chemical analyses of the glazes and of the leached solutions are shown in Table 1. The highest crystalline glaze, A, shows the highest amount of leached elements, with respect to all other glazes and in particular, with respect to the low crystalline glazes, D, E and F.

The chemical durability of the different phases after immersion in acid solution was estimated by SEM images. Fig. 1 shows the microstructure of the A glaze, with a high amount of crystals, before and after etching. The microstructure after attack is very heterogeneous with a lot of debris on the tile surface and a crazing effect with a silica-rich layer formation. In fact, the ion exchange reaction of alkalis and alkaline earths due to hydrogen and the formation of a silica layer is well known [2].

	A		B		C		D		E		F	
	CG	CL	CG	CL	CG	CL	CG	CL	CG	CL	CG	CL
Si	21,54	-	20,72	-	22,47	-	31,04	-	25,75	-	22,31	-
Al	6,90	1310	6,26	2,80	6,96	17,6	3,45	13,2	5,50	33,4	7,07	13,9
Ti	0,16	3,55	0	0	0,04	0,06	0,16	0	0,18	0,01	0	0
K	2,12	293	1,76	0,98	1,69	2,79	1,51	2,19	1,57	5,75	1,62	1,97
Ca	1,71	522	1,54	3,14	2,20	8,81	2,22	5,44	9,33	57,69	3,19	6,00
Fe	0	12,35	0	0,23	0	0,36	0,32	0,25	0,40	1,30	0,98	0,25
Mg	1,43	329	1,38	2,40	0,62	1,14	0,33	0	2,31	9,54	0	0
Na	2,20	1411	2,54	0	3,37	5,95	3,96	7,27	1,87	8,82	3,38	1,99
Zr	8,78	19,06	11,36	0,28	7,23	0,90	0	0,70	0	3,43	0	0,46
Zn	4,31	1245	3,87	0,35	4,54	10,46	4,43	4,13	2,20	11,03	7,51	4,10
Sn	0	0	0	0	0	0	0	0	2,70	10,70	0	0
Pb	6,20	1490	8,24	5,42	6,48	16,2	3,80	4,54	5,34	31,5	7,39	7,12
Ba	5,75	1110	4,30	0,27	5,04	19,1	4,67	11,50	0	0	6,05	15,4
Co	0	0	0	0	0	0	0	0	0	0	0,46	0,09
Cd	0	0	0	0	0	0	0,57	1,00	0	0	0	0
Cr	0	0	0	0	0	0	0	0	0,24	0,17	1,18	0
O	38,90	-	38,03	-	39,36	-	43,54	-	42,61	-	38,86	-

Table I - *Chemical analysis of the tested glazes (CG), wt%, and chemical determinations of the leached solutions after acid etching (CL), mg/l.*

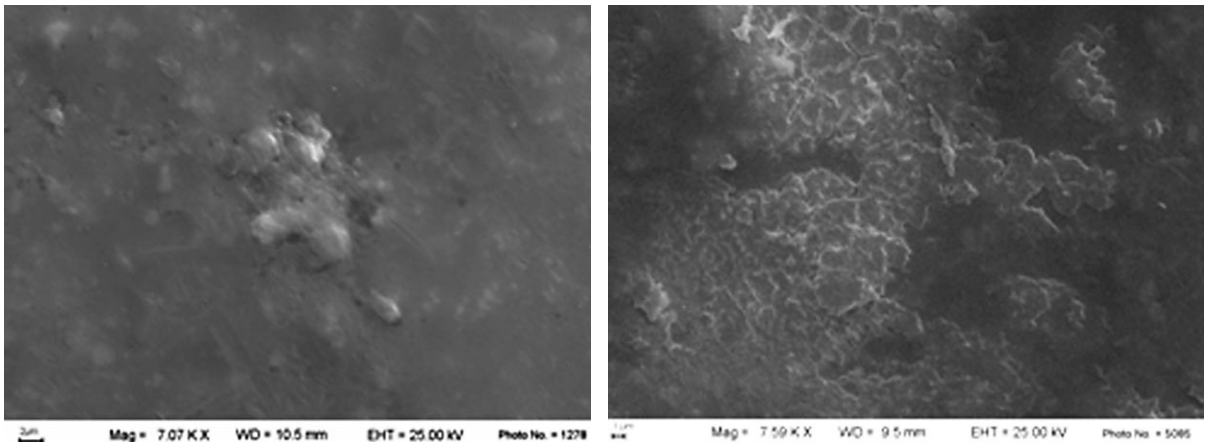

Figure 1 – *SEM micrographs of glaze A before (a) and after (b) chemical etching.*

CONCLUSION

The results made it possible to understand the mechanisms of the elements released as a result of chemical etching and their implications on the microstructural degradation of tile working surfaces. Due to the heterogeneity of the microstructure, high crystalline glazes show a more heterogeneous corrosion than low crystalline glazes in which a more uniform corrosion takes place on the amorphous phase.

REFERENCES

[1] EN ISO 10545-13, Ceramic tiles-Part 13: Determination of chemical resistance, 1995.

[2] A. Escardino, J.L. Amoròs, A. Gozalbo, M.J. Orts, F. Lucas, A. Belda, Interacción entre capas de esmalte durante la cocción. Resistencia química de los vidriados resultantes, Qualicer 2002, 201-217.