Achievements in Mechanical and Materials Engineering

COMMENT Worldwide Congress on Materials and Manufacturing Engineering and Technology
16th - 19th May 2005 Gliwice-Wisła, Poland

COMMITTEE OF MATERIALS SCIENCE OF THE POLISH ACADEMY OF SCIENCES, KATOWICE, POLAND
INSTITUTE OF ENGINEERING MATERIALS AND BIOMATERIALS OF THE SILESIAN UNIVERSITY OF TECHNOLOGY, GLIWICE, POLAND
ASSOCIATION OF THE ALUMNI OF THE SILESIAN UNIVERSITY OF TECHNOLOGY, MATERIALS ENGINEERING CIRCLE, GLIWICE, POLAND

13th INTERNATIONAL SCIENTIFIC CONFERENCE ON ACHIEVEMENTS IN MECHANICAL AND MATERIALS ENGINEERING

Surface observation by AFM of marble samples after thermal treatment

J. Lopes[a,b], Y. Nunes[a], M.J.P. Maneira[a] and M.P. Dos Santos[a,b]

[a] CeFITec, Universidade Nova de Lisboa – Faculdade de Ciências e Tecnologia ,Quinta da Torre, P-2829-516 CAPARICA, Portugal, E-mail: mpsantos@fct.unl.pt

[b] CeFITec and also Dept.Física-Univ.Évora, P-7000-671 ÉVORA, Portugal

Abstract: An atomic force microscope (AFM) study of marble samples of the same origin and submitted to two different thermal cycle treatments of variable duration was performed. The analysis of the first exploratory experiments tries to observe consistent changes in some physical parameters that can be related to the difference in duration of those thermal treatments. The aim of the whole project is to relate these results with possible damages originated by the thermal treatments in order to see if the thermal cycles used can reproduce some natural damage processes. Then, those studies should be enlarged to compare samples from two completely different origins.

Keywords: Atomic force microscopy, Marble, Rugosity, Grain size

1. INTRODUCTION

In recent years some degradation of marble covered facades, where the marble slabs exhibit a tendency towards concave bowing, has been reported [1]. Because of the regularity of this phenomenon, instead of a random distribution, it seems that it cannot be attributed to some intrinsic predisposition of the material, like the release of some internal stress. On the contrary, it seems that some heavy atmospheric conditions can be responsible for this damage. This subject of marble bending has been studied for seventy years, since Rayleigh [2], and some of the effects have been reproduced in laboratory, by heating the material. Acid-rain attack has also been invoked to explain these effects, because it would cause the disintegration of the binding material between grains, and the consequent lost of rock cohesion.

2. EXPERIMENTAL RESULTS

The experiments were performed with an atomic force microscope (AFM) TOPOMETRIX TMX 2000, using a dry scanner of 100 µm. We observed two similar samples of marble obtained from a Portuguese supplier of Borba (referred as A2 and A3). Two scannings were

obtained for each sample (noted as s1 and s2). These samples were submitted to different thermal treatments of icing and un-icing for 19 and 23 times, respectively.

The thermal cycles were performed by CEVALOR (Technological Centre for Ornamental and Industrial Stones Valorisation), in Borba (Portugal). CEVALOR is also preparing a new series of eight samples, from this Portuguese supplier and from an Italian one, in each case with three types of thermal cycles, and one without any treatment, for us to continue the experimental study, and they should allow us to generalise the preliminary results we obtained so far.

3. TABLE AND FIGURES

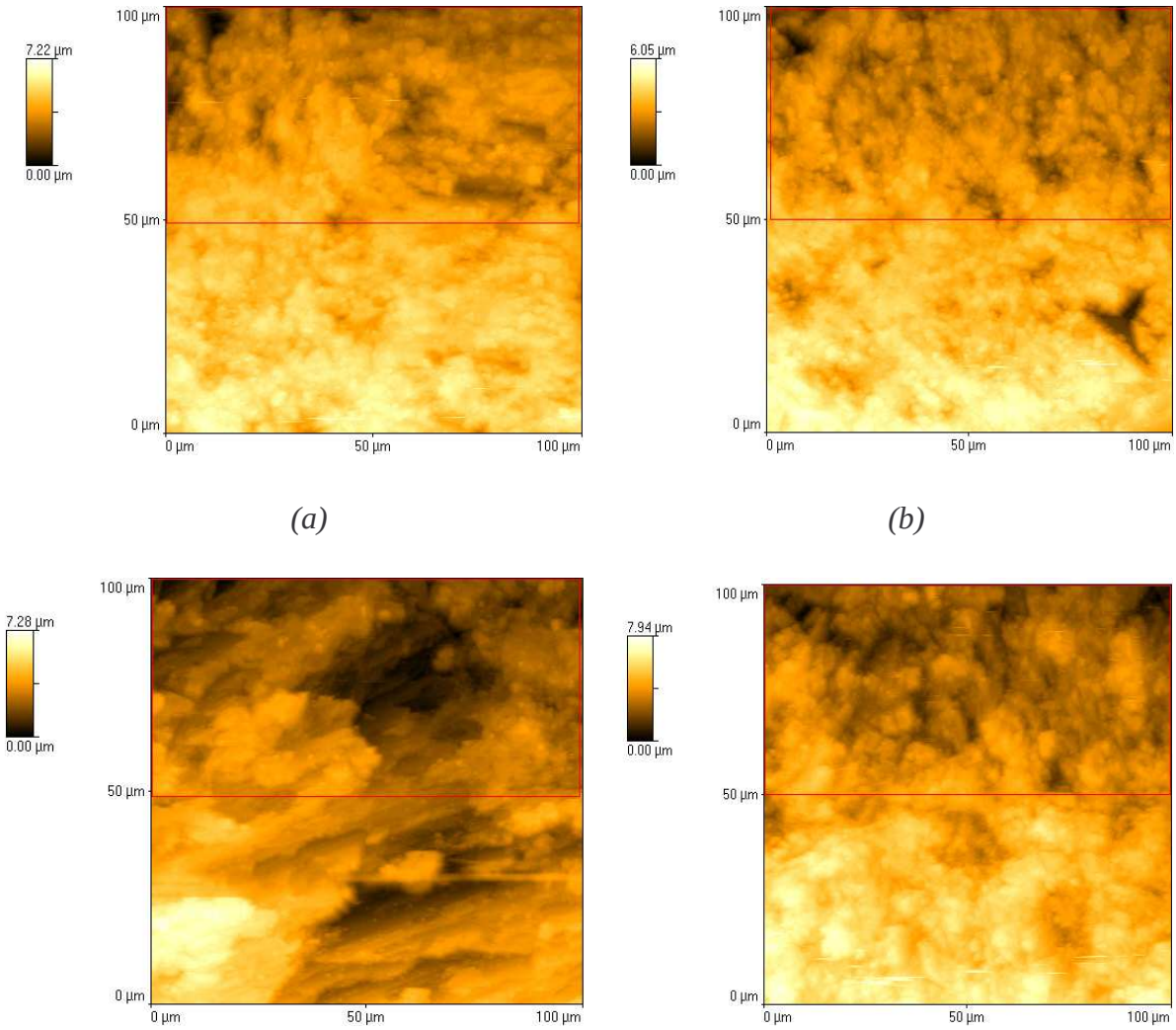
Table 1 shows the variations of some parameters between these two samples with different thermal treatment. In Figure 1 the topographic images of each of the scannings of each sample can be seen. The results from those figures have been treated with the software SPMLab, specific for this TOPOMETRIX equipment.

Table 1.
Variation of some parameters of the samples A2 to A3

	A2	A3	Increase %
Grain Volume/μm^3	**34233**	**43148.5**	**+ 26**
Grain Area/μm^2	**1924**	**2537**	**+ 32**
Grain Perimeter/μm	**6598.5**	**8363.5**	**+ 27**
Rugosity Area Rms (nm)	**1029.2**	**1340.4**	+ 30

4. CONCLUSION

From these preliminary results, an increase of grain size and of rugosity with the number of thermal cycles is shown. We believe that this result can be generalised, after the conclusion of the experiments on the new samples, and we intend to present those results in the Conference.



(a) *(b)*

(c) *(d)*

Figure 1. Topographic image of samples: (a) A2-s1; (b) A2-s2; (c) A3-s1; (d) A3-s2

ACKNOWLEDGEMENT

The authors are thankful to CEVALOR (Technological Centre for Ornamental and Industrial Stones Valorisation) for providing the samples and performing the thermal treatments.

REFERENCES

1. G. Royer-Carfagni, Constructing and Building Materials, vol. 13, p.449 (1999)
2. A. Rayleigh, Proc.R.Soc.London, p.266 (1934)