Feasibility analysis of using machinable glass ceramics to manufacture non-contact measurement approach metrological artefacts

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1. Introduction

In the last decades, numerous non-contact measurement methods have been developed. These methods permit to capture much more quantity of information than contact ones in less time and also with less problems of accessibility. These advantages convert them in ideal for on-machine and in-process measurement tasks. Nevertheless, it is widely and well known that the quality of the results achieved by them are highly influenced by different conditions which are usually indifferent to contact ones (optic characteristics of the surface measured, light ambient conditions, etc.). This fact, added to the important need for metrological artefacts in order to assess quality of the results and their traceability, makes that nowadays still exist the necessity to develop specific non-contact measurement focused metrological artefacts. These artefacts must be produced using materials that avoid the characteristic problems arising during digitising with non-contact sensors.

In this work, the feasibility of a commercial machinable glass ceramic to manufacture in order to manufacture metrological artefacts is analysed. Macor® machinable glass ceramic [1] of the commercial trademark Final Advanced Materials is studied, both checking the quality of the information captured over this material by a widely used non-contact laser triangulation metrological sensor, and analysing the possible problems that may arise when this material is machined with the aim to produce typical metrological geometries. The feasibility of this material is demonstrated and specific machining procedures, and also conditions, focused to obtain different types of geometries are proposed.

2. Methodology

This work can be divided in two parts. On one hand, the feasibility of using Macor® as non-contact sensor-friendly material for a laser triangulation sensor was demonstrated. For that, the quantity of points captured with this sensor and their geometrical quality were analysed using the measurements provided by a CMM Touch Probe system as reference. Moreover, these results were also compared with those obtained with the same sensor over a very used material to manufacture metrological artefacts, i.e. stainless steel.

On the other hand, several machining conditions based on Macor® manufacturer recommendations were optimized for machining the artefact geometries, and to discuss the problematic associated to these tasks. The quality of various machined surfaces was analysed by means of different methods as visual inspection, microscopy and roughness measurement.

3. Results and Discussion

The results obtained in the first part of this work demonstrates the good optical behaviour of the non-contact sensor in the digitizing of the Macor® material compared with its behaviour over the stainless steel. This demonstrates the non-contact sensor-friendly characteristics of this material.

On the other hand, different problems in the machining stage were detected related mainly to the fragility that shows this material due to its low toughness. A resin-embedded procedure was proposed, Figure 1, and different machining conditions were determined in order to both protect the integrity of the material and achieve the maximum quality of the artefact.

Figure 1. Embedded Macor® block during machining.

4. Conclusions

Macor® machinable glass ceramic is an interesting material to manufacture non-contact metrological artefacts by means of machining tasks but in specific conditions.

5. References

[1] Corning, MACOR® Machinable Glass Ceramic for Industrial Applications, Datasheet, 2012.