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Manufacturing and Calibration of Material Standards for Optical Microscopy in Industrial Environments

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Abstract : It seems that we live in a world in which the trend in industrial environments is the miniaturization of systems and materials and the fabrication of parts at the micro-and nano-scale. The problem arises when manufacturers want to study the quality of their production. This characteristic is becoming crucial due to the evolution of the industry and the development of Industry 4.0. As Industry 4.0 is based on digital models of production and processes, having accurate measurements becomes capital. At this point, the metrology field plays an important role as it is a powerful tool to ensure more stable production to reduce scrap and the cost of non-conformities. The most extended measuring instruments that allow us to carry out accurate measurements at these scales are optical microscopes, whether they are traditional, confocal, focus variation microscopes, profile projectors, or any other similar measurement system. However, the accuracy of measurements is connected to the traceability of them to the SI unit of length (the meter). The fact of providing adequate traceability to 2D and 3D dimensional measurements at micro-and nano-scale in industrial environments is a problem that is being studied, and it does not have a unique answer. In addition, if commercial material standards for micro-and nano-scale are considered, we can find that there are two main problems. On the one hand, those material standards that could be considered complete and very interesting do not give traceability of dimensional measurements and, on the other hand, their calibration is very expensive. This situation implies that these kinds of standards will not succeed in industrial environments and, as a result, they will work in the absence of traceability. To solve this problem in industrial environments, it becomes necessary to have material standards that are easy to use, agile, adaptive to different forms, cheap to manufacture and, of course, traceable to the definition of meter with simple methods. By using these ‘customized standards’, it would be possible to adapt and design measuring procedures for each application and manufacturers will work with some traceability. It is important to note that, despite the fact that this traceability is clearly incomplete, this situation is preferable to working in the absence of it. Recently, it has been demonstrated the versatility and the utility of using laser technology and other AM technologies to manufacture customized material standards. In this paper, the authors propose to manufacture a customized material standard using an ultraviolet laser system and a method to calibrate it. To conclude, the results of the calibration carried out in an accredited dimensional metrology laboratory are presented.

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