In Materio Should Be Used Instead of In Materio

Carlo Ricciardi1* and Gianluca Milano2

1Department of Applied Science and Technology, Politecnico di Torino, Torino, Italy, 2Advanced Materials Metrology and Life Sciences Division, INRiM (Istituto Nazionale di Ricerca Metrologica), Torino, Italy

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INTRODUCTION

Scientific writing frequently uses Latin words and phrases. In most cases, the reason is an evident continuity in exploiting the same terms from ancient (and famous) scientists and sources. However, in some cases, such expressions are proposed in contemporary times with an updated meaning.

This short opinion article is intended to shed some light on one such “new” Latin expressions in science: in materio.

ORIGIN OF IN MATERIO

In materio was reported for the first time in a preceding paper by Miller and Downing (2002). The expression was not explicitly defined, but it was discussed in a framework where biological evolution is envisioned as a tool to tune the physical properties of electrical devices.

More than 10 years later, Miller recalled and updated the in materio expression, as connected to the implementation of computational paradigms on physical systems as black boxes (Miller et al., 2014). Soon after, in materio started being associated especially with physical reservoir computing implemented on designless nanonetworks (van Damme et al., 2016; Dale et al., 2017a, 2017b; Przyczyna et al., 2020; Banerjee et al., 2021; Boon et al., 2021; Kotooka et al., 2021; Lilak et al., 2021; Usami et al., 2021). Very recently, the same meaning was attributed to a slightly different Latin expression: in materia (Milano et al., 2021). Which one is correct?

DISCUSSION

We believe the correct form should be “in materia.”

Indeed, in materia is the literary Latin expression for “in the matter.” In Latin, when the in preposition is meant as “inside/within,” the noun should be put in the ablative case. Since materia-ae is a feminine noun of the first declension, its ablative case is materia, not materio. Previous authors using in materio were likely misled by similar Latin expressions used in science that finish in -o, such as in vivo or in vitro. But vivum-i and vitrum-i are neutral nouns of the second declension, so their ablative is correctly vivo and vitro, respectively.

There is a similar, prior, and more famous example of an incorrect Latin expression used in physics and computer science since the eighties: in silico. However, here no clear correct Latin expression really exists as in silico refers to computer CPUs made “in silicon,” while silicon was discovered as an element by Berzelius in the early 19th century. Therefore, “silicon” is not a Latin word, even if it may sound like one. The more suitable Latin word would probably be silex-silicis, but this referred to generic hard stones like silicates, and its ablative (third declension) would be in silice.

On the contrary, in materio has a correct Latin expression—in materia—that we believe should be recognized and spread.
AUTHOR CONTRIBUTIONS

CR made the literature review and wrote the manuscript. CR and GM discussed the results and finalized the manuscript.

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REFERENCES

Banerjee, D., Azhari, S., Usami, Y., and Tanaka, H. (2021). Room Temperature Demonstration of In-Materio Reservoir Computing for Optimizing Boolean Function with Single-Walled Carbon Nanotube/porphyrin-Polyoxometalate Composite. Appl. Phys. Express 14, 105003. doi:10.35848/1882-0786/ac24db. Boon, M. N., Euler, H. R., Chen, T., Ven, B., Ibarra, U. A., Peter, A., et al. (2021). Gradient Descent in Materio. Ithaca, NY: Cornell University.

Dale, M., Stepney, S., Miller, J. F., and Trefzer, M. (2017a2017). Reservoir Computing in Materio: A Computational Framework for in Materio Computing. Proc. Int. It. Conf. Neural Networks, 2178–2185. doi:10.1109/IJCNN.2017.7966119

Dale, M., Stepney, S., Miller, J. F., and Trefzer, M. (2016b). Reservoir Computing in Materio: An Evaluation of Configuration through Evolution. IEEE Symp. Ser. Comput. Intell. SSCl. doi:10.1109/SSCl.2016.7850170

Kotooka, T., Lilak, S., Stieg, A., Gimzewski, J., Sugiyama, N., Tanaka, Y., et al. (2021). Ag2Se Nanowire Network as an Effective In-Materio Reservoir Computing Device. Res. Sq., 1–20. doi:10.21203/rs.3.rs-322405/v1

Lilak, S., Woods, W., Scharnhorst, K., Dunham, C., Teuscher, C., Stieg, A. Z., et al. (2021). Spoken Digit Classification by In-Materio Reservoir Computing with Neuromorphic Atomic Switch Networks. Front. Nanotechnol. 3, 1–11. doi:10.3389/fnano.2021.675792

Milano, G., Pedretti, G., Montano, K., Ricci, S., Hashemkhani, S., Boarino, L., et al. (2021). In Materia Reservoir Computing with a Fully Memristive Architecture Based on Self-Organizing Nanowire Networks. Nat. Mater. doi:10.1038/s41563-021-01099-9

Miller, J. F., and Downing, K. (2002). Evolution in Materio: Looking beyond the Silicon Box. In Proc. - Nasa/dod Conf. Evolvable Hardware, EH 2002-janua, 167–176. doi:10.1109/EH.2002.1029882

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