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3D LASER STRUCTURIZATION OF LUMINESCENT MATERIALS

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Luminescent materials have a wide array of different applications: from extensive use in lightings, displays and in medicine as markers to more niche uses as high temperature and pressure sensors. Furthermore, studies of luminescent materials have also been gaining more traction due to new innovative methods of their manufacturing as well as new quite promising applications. In this study a wide array of luminescent materials, as well as some initial results of synthesis and experimentation on luminescent materials will be provided and reviewed.

Luminescent materials used in laser structurization can be divided into two categories: organic and hybrid materials. Some good examples of a polymer doped with organic dyes were presented by A. Žukauskas et al. [1], and C.R. Mendonca et al. [2]. The main drawbacks of pure-organic phosphors as dopants seem to be low concentration and photostability of the dye in polymer matrix. A different example of a polymer doped using inorganic dopant was shown by J. Winczewski et al. [3]. In the aforementioned source, the only mentioned drawback is nonradiative relaxation. It should also be noted that while purely organic phosphors have a characteristic wider emission spectre, inorganic phosphors have a narrow emission spectre. Some promising results were also obtained in this study on the subject of YAG $(Y_3Al_5O_{1_2})$ synthesis inside a structurized polymer by utilising a femtosecond laser system. Figure 1 shows SEM images of microstructures obtained by laser irradiation:

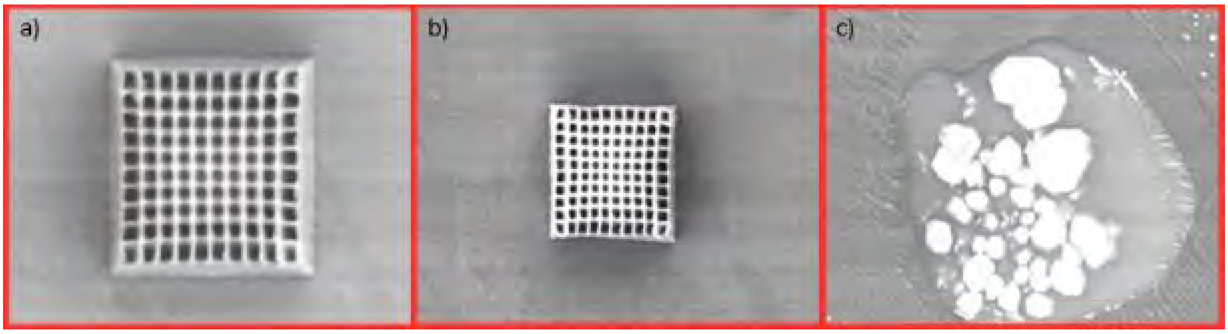

Fig. 1. 2500 times enlarged SEM image of a) microstructures obtained post-laser irradiation b) microstructures obtained after heating the sample in 600°C temperature c) microstructures obtained after further heating the sample in 1600°C temperature.

Initial results of the study show that polymer microstructures shrink when heated at 600°C. At 1600°C calcination removes the organic matter while leaving behind crystalline inorganic YAG. Unfortunately, synthesized YAG hasn
't retained the structures obtained during laser irradiation, so it
's still a work in progress and the method has yet to be perfected.

This study shows that both types of luminescent materials still seem to have their characteristic drawbacks and as such can still be improved.

[1] A. Žukauskas, M. Malinauskas and the others. Organic dye doped microstructures for optically active functional devices fabricated via two-photon polymerization technique. Lith. J. Phys.. 2010. 50. 55-61.
[2] C.R. Mendonca, D.S. Correa and the others. Three-dimensional fabrication of optically active microstructures containing an electroluminescent polymer. Appl. Phys. Lett.. 2009. 95. 113309.
[3] J. Winczewski, M. Herrera and the others. Additive Manufacturing of 3D Luminescent ZrO2:Eu3+ Architectures. Adv. Opt. Mater.. 2022. 10. 2102758.