

GRAPHENE-BASED MATERIALS AS A TOOL FOR IMPROVING LONG-TERM STORAGE OF CULTURAL HERITAGE ITEMS

G. Gorgolis^{1,2*}, Steffen Ziemann³, Maria Kotsidi¹, George Paterakis^{1,2}, Nikos Koutroumanis¹, Christos Tsakonas¹, Manfred Anders³ and Costas Galiotis^{1,2*}

¹Institute of Chemical Engineering Sciences, Foundation of Research and Technology-Hellas (FORTH/ICE-HT), Stadiou Street, Platani, 26504 Patras, Greece

²Department of Chemical Engineering, University of Patras, 26504 Patras, Greece

³Zentrum für Bucherhaltung GmbH (ZFB), Bücherstraße 1, 04347 Leipzig, Germany

(*gorgolis@iceht.forth.gr, c.galiotis@iceht.forth.gr)

ABSTRACT

The very serious problem of temperature and humidity regulation, especially for small and medium-sized museums, galleries, and private collections, can be mitigated by the introduction of novel materials that are easily applicable and of low cost ^[1,2]. Within this study, archive boxes with innovative technology are proposed as “smart” boxes that can be used for storage and transportation, in combination with a nanocomposite material consisting of polyvinyl alcohol (PVA) and graphene oxide (GO). The synthesis and characterization of the PVA/GO structure with SEM, Raman, AFM, XRD, Optical Microscopy, and profilometry are fully discussed. It is shown that the composite material can be integrated into the archive box either as a stand-alone film or attached onto fitting carriers, for example, those made of corrugated board. By applying the PVA/GO membrane this way, even with strong daily temperature fluctuations of $\Delta T = \pm 24.1^\circ\text{C}$, strong external humidity fluctuations can be reduced by -87% inside the box. Furthermore, these humidity regulators were examined as Volatile Organic Compounds (VOCs) adsorbers since gas pollutants like formic acid, formaldehyde, acetic acid, and acetaldehyde are known to exist in museums and induce damages in the displayed or stored items ^[3]. High rates of VOC adsorption have been measured, with the highest ones corresponding to formic acid (521% weight increase) and formaldehyde (223% weight increase).

KEYWORDS: Cultural heritage, temperature/humidity regulators, graphene, poly-vinyl alcohol

REFERENCES

- [1] Kotsidi M, Gorgolis G, Galiotis C et al. (2021). *Nature Nanotechnology*, 16, 1004-1010.
- [2] Kotsidi M, Gorgolis G, Galiotis C et al. (2023). *Nanoscale*, 15, 5414-5428.
- [3] Gorgolis G, Kotsidi M, Galiotis C et al. (2022). *Chemistry NanoMaterials*, 8, e202200265.