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IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
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3D PRINTED COMPOSITE ASSESSMENT BY HYPERSPECTRAL ANALYSIS

Abstract

Hyperspectral analysis is a well-established technique to process satellite data for precisely detecting specific events from Earth observation. The potential of this approach can be implemented in several application fields including, e.g., food industry, chemical assessment, and materials science. Hyperspectral images contain spatial and spectral information of the investigated sample at very high resolution. This characteristic can be usefully considered to evaluate materials properties at a nanoscale level, especially when ad hoc composites have to be fabricated and the related expected performance is strictly related to an effective and homogenous distribution of the filler within the matrix. As a proof of concept, hyperspectral imaging was here considered to investigate 3D printed polymer matrix composites with graphene oxide as nanofiller. Additive manufacturing can actually contribute to fabricate suitable composites taking advantage of the intrinsic design properties provided by this kind of technology. Geometrically complex and functional components can be readily produced, but a detailed analysis on the resulting characteristics and performance should be carefully carried out. As a case study, commercial polycaprolactone and polylactic acid filaments were modified with graphene oxide (GO) to be printed into simple testing specimens. Raman analysis was then performed in order to evaluate the GO distribution on samples surface by mapping different regions of interest. The collected data were the input of a custom-made algorithm for hyperspectral imaging as well, tailored to detect the GO signature. Findings clearly highlighted the potential of this approach, showing a valuable matching to Raman maps and being also characterized by the positive feature of avoiding to set specific conditions to obtain the map of interest. Indeed, the detection of GO distribution by Raman mapping was carried out fixing the wavenumber at 1580 cm-1, representative of the G band of the nanofiller. This might lead to an uneven intensity representation related to possible peak shifts which can then bias the acquired results. Differently, hyperspectral imaging needs a minimal set of input data, i.e. the spectral signatures of the neat materials, to directly identify the searched nanomaterial. More in depth investigations should be performed in a relevant environment to fully validate the proposed approach, but the here presented results already show the potential and versatility of hyperspectral analysis in the materials science field.