3D Porous Graphene-Based Double Polymeric Networks for Controlled Drug Delivery

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Efficient drug delivery plays an essential role in disease treatment and remains an important challenge in medicine. Recent advances in the field of polymer technology have fuelled the research of smart materials like hydrogels, in which drug delivery is triggered by changes in environmental factors [1]. Furthermore, three-dimensional (3D) polymeric aerogels are attracting ever-growing attention as hosts in hydrogels, which enable to carry the drug for the delivery.

The aim of this work is the investigation of graphene-based aerogels combined with polysaccharide hydrogels for use in controlled drug delivery. A porous graphene based polyvinylidene fluoride (PVDF) aerogel, produced through a cost-effective procedure [2], is integrated with a second polymeric network formed by ionotropic gelation of alginate. The so obtained aerogel-alginate systems have been characterized in terms of porosity, density, morphological and drug release properties. Figure 1(a) shows an SEM image of neat PVDF sample, while Figs. 1 (b) and (c) show SEM images at different magnifications of a PVDF aerogel filled with 11% wt. of graphene nanoplatelets (GNPs). Both samples are characterized by a homogeneous structure. Moreover, a good adhesion of GNPs to the polymer matrix is noticed: GNP surfaces are almost entirely covered by the PVDF polymer chains.

The novel systems are able to entrap and control the release of a hydrophilic model molecule, such as vitamin B12. Figure 2(a) reports the drug release as function of time before and after crosslinking with Ca(II). A marked difference can be observed between the two systems, thus we can conclude that ionotropic gelation of alginate effectively occurred within PVDF network and a double network is formed. Similar results are obtained for PVDF/GNP aerogel (Fig 2(b)). Moreover, ot is noticed that GNP addition improves significantly the entrapment efficiency of vitamin B12, which increases from 7.6±0.1% of PVDF/alginate to 61.2±7.4% of PVDF/GNP/alginate systems. This is due to the different network structure of the GNP-filled foam, since the addition of GNPs modify the porosity.

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References

[1] Merino, S, et al (2015). ACS Nano, 9(5). 4686-4697
[2] H.C Bidsorkhi, et al, IEEE NANO (2018) pp1-4

Figures

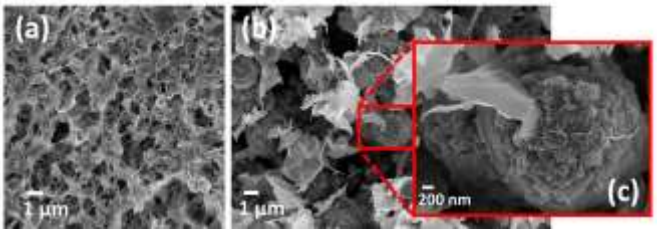

Figure 1: SEM images of neat PVDF aerogel (a) and of GNP-PVDF aerogel (b) samples.

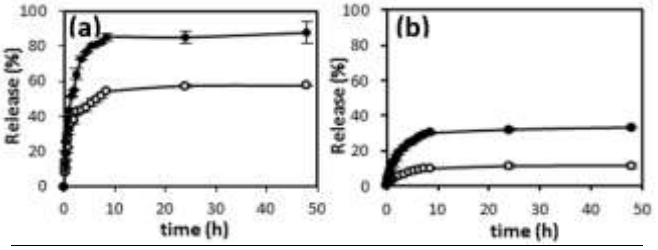

Figure 2: Release profile of vitamin B12 from (a) PVDF/alginate and (b) PVDF/GNP/alginate systems in phosphate buffer (pH 7.4) at 37.0±0.1°C. Full circles refer to not crosslinked alginate, whereas empty circles refer to crosslinked alginate.