Graphene oxide ovalbumin nano-complexes in liquid formulation for immunomodulation

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Abstract

Graphene oxide (GO) is an ideal water dispersible and mechanically flexible, drug carrier nanomaterial, with a specific surface area of ≈ 740 m_2 g^{-1} [1], with chemically heterogeneous planar surface for functionalisation and tunable diffusion via controlled lateral size. *In vivo* biodistribution studies of bare GO [2, 3] have indicated that upon intravenous (i.v.) injection in mice the material is accumulated in the spleen, which has important immunological functions. Furthermore, recent studies have indicated that GO in complex with ovalbumin (OVA) can offer immunomodulatory activity *in vitro* and *in vivo* [4].

In order to assess the GO potential as a nano-carrier for drug delivery to the spleen we formulated and characterised pharmaceutical dispersions of GO in complex with ovalbumin (OVA). Then, we studied the *in vivo* biodistribution of the GO:OVA complexes, by dynamic whole-body imaging (μSPECT:CT), histology and Raman mapping. OVA exhibited affinity for the GO nanosheets, with AFM demonstrating that GO upon complexation with OVA protein was still dispersed as individual flakes of single to few-layer thickness. Raman indicated that the GO chemical structure was not alterered. The pH strictly influenced the dispersion stability, suggesting that adsorbed OVA prevented aggregation of the complexes by means of electro-steric stabilization. Remarkably, administration of GO:OVA complexes *in vivo* by i.v. injection showed clear positive Raman signal in the spleen, indicating a great potential of GO nanosheets as platforms for immunotherapeutic applications.

References

[1] Montes-Navajas *et al.*, Langmuir, 29 (2013)13443
[2] Jasim *et al.*, Chemical Science, 6 (2015) 3952
[3] Jasim *et al.*, Applied Materials Today 4 (2016) 24
[4] Parker *et al.*, Nanoscale, 14 (2022) 17297

Figures

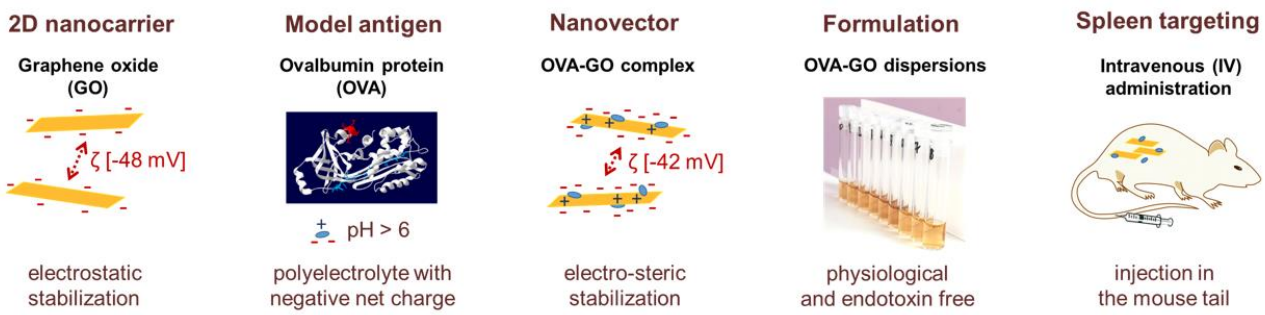

Figure 1: Graphene oxide is a promising nanocarrier for the delivery of proteins to the spleen for immunomodulation applications.