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Biomedical Application of Nanocarbons

ナノ炭素材料の生物医療応用

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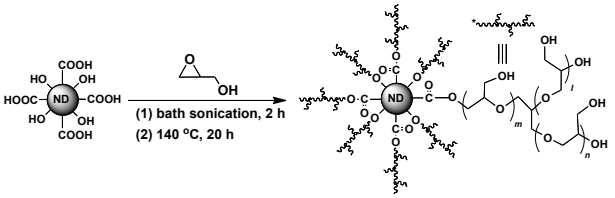
Biomedical applications of nanodiamond (ND) have been investigated extensively due to its low toxicity, non-bleaching fluorescence and high extensibility of the surface functionality through covalent organic functionalization.[1] For in vivo applications such as drug carrier and imaging probe, ND should form a stable hydrosol under a physiological environment to avoid embolism. In this context, we recently found that polyglycerol (PG) functionalization is very effective to impart the sufficient solubility and stability to ND (Scheme 1).[2] In addition, we established the methodology to derivatize ND-PG through organic transformations at a number of hydroxyl groups on the PG layer to add requisite functions for the in vivo applications.[3-6] As a result, we successfully prepared the ND-based drug carrier with acid-responsive release of the anti-cancer drugs,[3,4] gene carrier with plasmid DNA[5] and MR imaging probe with gadolinium [3]. We also developed fluorescence ND-based cell labeling agent with intrinsic non-bleaching and non-blinking fluorescence from the N-V center in the diamond core.[3]

The PG functionalization to ND was performed through ring-opening polymerization of glycidol at high temperature under neutral conditions as shown in Scheme 1. The PG functionality provides good dispersibility in a physiological environment, realizing chromatographic separation of the PG functionalized ND according to the size.[2] This methodology of PG functionalization and chromatographic separation is found to be applied to various kinds of nanomaterials such as superparamagnetic iron oxide nanoparticle (SPION),[7] zinc oxide nanoparticle,[8] carbon nanotubes and graphene. PG-functionalized graphene was soluble in water without damaging the pristine graphene structure, which is not like graphene oxide (GO).

The fundamentals in surface modification and size control of nanomaterials, mentioned so far, provide flexibility in materials design to adjust various biomedical applications in diagnosis and therapy.



Scheme 1. PG functionalization of ND through ring-opening polymerization of glycidol.

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