The Difunctional Features of Grapheme Oxide in Amyloid Aggregation

Yanlian Yang*, Huan Huang, Qunxing Huang, Maryam Yousaf, Changliang Liu, Min Zhang, Chen Wang*

National Center for Nanoscience and Technology, 11 Beiyitiao, Zhaongguancun, Beijing, China
yangyl@nanoctr.cn

Abstract

The unique structures and properties of grapheme oxide (GO) and grapheme quantum dots (GQD) facilitate hem promising nanomaterials in biological applications. The conformations of proteins are vital for their functions and conformation change and aggregation of proteins with rich β-sheet structures are associated with may important degenerative diseases. In the previous reports, we observed the conformation change of alfa-helical peptide into beta-sheet secondary structures upon adsorption on graphite surface [1]. Later, we demonstrated that graphene oxide could strongly interact with key HIV peptide, Vpr13-33, giving rise to the transition in conformation, morphology changes of aggregates, and ultimately reduced cytotoxicity of Vpr13-33 peptide [2]. Considering the common interaction mechanisms between peptide/small molecule and peptide/carbon nanomaterials [3-5], according to our reports on molecular level investigation on modulation of amyloid aggregations using small molecules, the above works provide possibility of the exploration of the interaction between peptide and carbon-based materials for diagnosis and treatment of conformational diseases.

The detection of amyloid's aggregation is of great importance in diagnosis of the amyloidogenesis. Conventional fluorescent dyes, such as thioflavin-T (ThT), usually undergo co-incubation with amyloid peptides, which could lead to disturbance of the aggregation because of their inhibitory effect. Herein, we propose a method to detect the aggregation of amyloid β (Aβ) peptides by utilizing the fluorescence characteristics of graphene quantum dots (GQDs) without co-incubation process. The linear dependence of the photoluminescence (PL) intensity of GQDs on Aβ monomer concentration can be identified. It can be illustrated that both monomeric and fibrillar Aβ peptides can be monitored by using GQDs. Similar Aβ aggregation dynamics observed by using GQDs and ThT demonstrated the feasibility of GQD-based detection method without co-incubation with soluble amyloid peptides [6]. The modulations of amyloid aggregation including Aβ and amylin peptides by GO, GQDs and fluorinated GQDs (FGQDs) [7-9] have also been investigated. We demonstrated that the aggregation dynamics could be retarded by the carbon nanomaterials, which is a strong indication that GO and GQDs could be effective inhibitors for amyloid aggregation. The rescued cytotoxicity of the amyloid peptides by GO and GQDs also proved the feasibility of modulation of amyloid aggregation behaviors. The bifunction of carbon-based nanomaterials could shed light on pathological detection and diagnosis, prevention and treatment of degenerative diseases associated with amyloid aggregations.

References

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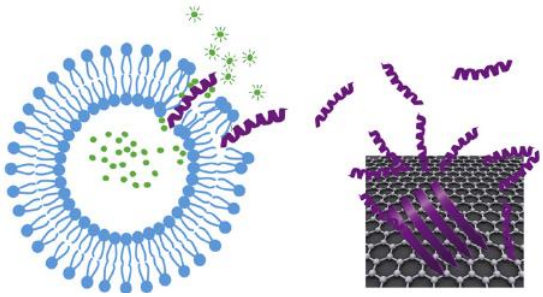
Figures



The conformational change of peptide upon adsorption on GO surface.