proceedings

Abstract

Mitigation of Metal Oxide Nanotoxicity with Functional Fibrils †

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† Presented at the International Conference EcoBalt 2023 "Chemicals & Environment", Tallinn, Estonia, 9–11 October 2023.

Keywords: amyloid fibril; metal ion; nanoparticle; binding; toxicity

Citation: Wang, Y.; Liang, X.; He, F.; Tang, H.; Yin, X.; Andrikopoulos, N.; Li, Y.; Mortimer, M.; Peng, G.; Ke, P.C. Mitigation of Metal Oxide Nanotoxicity with Functional Fibrils. *Proceedings* **2023**, *92*, 5. https://doi.org/10.3390/proceedings2023092005

Academic Editors: Anne Kahru, Ivo Leito, Riin Rebane and Villem Aruoja

Published: 21 November 2023

The toxicity of metal oxide nanoparticles has been a central research topic over the past two decades, owing to the domestic and industrial applications of this vast class of nanomaterials [1]. In the literature, ion release has been implicated as a primary cause for metal oxide nanotoxicity, coupled with the distinct physicochemical properties (e.g., large surface area, ready diffusion and dissolution, and strong adsorption) of nanoparticles, in comparison with bulk materials [2,3]. However, few solutions have been proposed thus far for overcoming the toxicity of metal oxide nanoparticles in vitro and in vivo. In this study, we engineered functional amyloid fibrils [4] using beta lactoglobulin (blg), a major whey protein, and demonstrated a scheme of ion sequestration by blg amyloid fibrils co-incubated with CuO or ZnO nanoparticles, using inductively coupled plasma mass spectrometry (ICP-MS). Our computer modeling revealed that blg fibrils possessed multiple binding sites for Cu^{2+} and Zn^{2+}, while strong binding of the metal ions often occurred at the Cys-121 residues of the fibrils. In addition, our cell viability and reactive oxygen species assays implicated blg amyloid fibrils as a functional nanomaterial with minimal toxicity. This study offered a facile engineering strategy for remediating the toxicity of metal oxide nanoparticles for facilitating their safe biological and environmental applications.

Author Contributions: Conceptualization, P.C.K.; methodology, Y.W., G.P. and X.L.; simulation, H.T.; data collection and analyses, Y.W., X.L., F.H., H.T., X.Y., N.A., Y.L., M.M. and G.P.; writing, Y.W., N.A., F.H., G.P., M.M. and P.C.K.; supervision, G.P. and P.C.K.; funding acquisition, G.P. and P.C.K. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the National Key Research and Development Program, Ministry of Science and Technology of China (2021YFA12009000, 2022YFC2409700), National Natural Science Foundation of China (T2250710182), and Fundamental Research Funds for the Central Universities of China.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data from this study may be requested to Prof. P.C. Ke.

Conflicts of Interest: The authors declare no conflict of interest.

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