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A REVIEW ON THE TRANSFORMATIONS OF THE NANOMATERIALS WITH THE EFFECT OF THE ENVIRONMENT

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Abstract

The field of nanotechnology continues to expand rapidly and the increasing use in commercial products of engineered nanomaterials (NMs) translates into a growing presence in the biosphere.Increasing the use of engineered nanomaterials with novel properties has created a need to identify their environmental behaviors and impacts relative to their bulk counterparts.Engineered NMs are processed materials that have at least one nanoscale dimension (approx. 1-100 nm) on the scale.In environmental media, the high surface area to volume ratio of nanoparticles results in extremely reactive and physio-chemically dynamic materials. Multiple transformations, such as responses to responses with in both environmental and biological systems, bio-macro-molecules, redox reactions, aggregation, and dissolution can arise. The fate, transportation, and toxicity of nanomaterials will change these transformations and others.Before substantial progress can be made in understanding the environmental threats posed by these products, the existence and scale of these transformations must be known.

Keywords: *Bi-macromolecules, Nanomaterials, Transformations,Toxicity.*

I. INTRODUCTION

The field of nanotechnology continues to expand rapidly and the increasing use in commercial products of engineered nanomaterials (NMs) translates into a growing presence in the biosphere[1]. Engineered NMs are processed materials that have at least one nanoscale dimension (approx. 1-100 nm) on the scale.[2] In the ecosystem, naturally occurring NMs are also widespread, arising from both natural processes and anthropogenic effects (e.g., flocculation of nanometer-scale metal oxides in acid mine drainage).Compared to a larger substance of the same chemical composition, the extremely small sizes of both naturally occurring and engineered NMs result in a high percentage of surface atoms that can result in new properties and reactivity. Examples of such engineered NMs include semiconductors such as quantum dots that have different optical and electrical properties depending on their size. NMs are becoming increasingly complex and include those with coatings targeting particular cells in the body or designed for optimized utility from more than one NM (e.g., quantum dot doped carbon nanotubes (CNTs))[3]. These newly emerging materials are special and xenobiotic, which will soon join industry supply chains (e.g., metal oxide NP-decorated graphene sheets).In environmental systems, the absence of a natural analog for these new materials complicates the forecasting of their fate, transport, reactivity and toxicity.People and governments around the world have been worried about the unknown effects arising from the novel properties displayed by NMs, and a justified increase in environmental health and safety (EHS) studies aimed at evaluating the potential for NMs to affect the environment or human health[4]. An overall aim of these research activities is to compare the characteristics of NMs with their environmental activity and their impacts on living organisms.

An understanding of the possible routes of exposure and toxicological effects from acute and chronic exposures is needed to determine the environmental and human health consequences of nanomaterials. The key focus of the global research effort to date has been to identify the fate, transport and toxic properties of nanomaterials that are pristine or "as manufactured". The high surface to volume ratio and reactivity, however,NMs in environmental processes render them extremely complex. The resulting changes in the NMs would affect the fate, transport and toxic properties of the NMs. For instance, in the atmosphere, metallic silver NPs will oxidize and can become sulfidized.Sulfidation of the particles, as well as their ability to release toxic Ag^+ ions and thus their persistence and toxicity, affects their aggregation state, surface chemistry, and charge. Similarly, the interaction between NMs and humic substances (HS) like natural organic matter (NOM) results in a nanoscale coating of NMs that is analogous to protein coronas in mammalian systems, altering their aggregation, deposition and toxic properties drastically[5][6].Due to complex and stochastic environmental processes, the physicochemical changes that follow engineered and accidental coatings, as well as subsequent environmental reactions, significantly complicate the understanding of the risks associated with environmental release of NMs.

In environmental and biological systems, we currently lack adequate knowledge of the forms, speeds, and extent of transformations required for NMs[7]. We also fail to grasp, by implication, the effect of these transformations on the fate, transport, and toxicity of NMs. We must aim to expand our understanding of NM transformations in order to accurately predict the environmental and human health risks associated with these products.

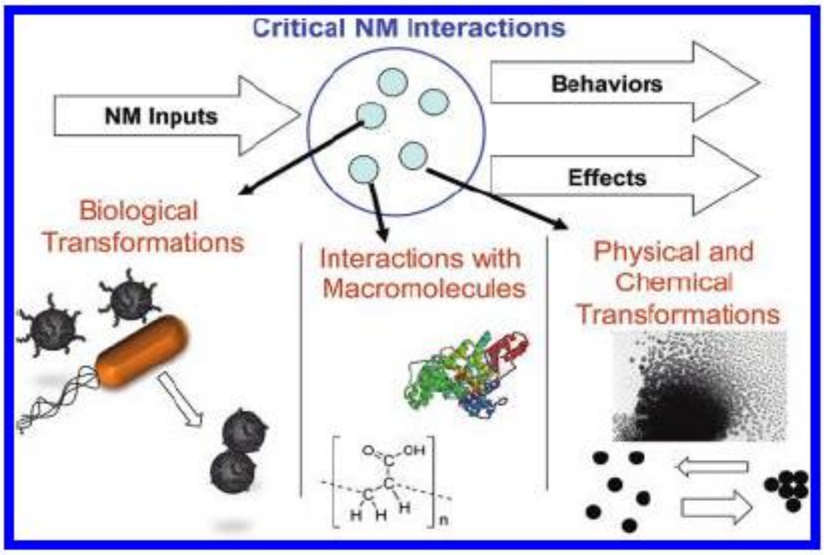

Figure 1: Nanomaterial transformations are critical processes affecting NM interactions. Transformations include physical and chemical transformations, biologically mediated transformations, and interactions.

In the atmosphere and in biological systems, oxidation and reduction (redox) reactions, degradation, sulphidation, aggregation, and adsorption of macromolecules and molecules/ions all occur readily[8][9]. Such transformations have a significant impact on NM behaviour. In certain cases, these improvements can increase the potential for toxicity (e.g., chemical weathering of a Cd-Se quantum dot shell that releases toxic ions from the particle particles).These improvements have been shown to decrease effects in other cases (e.g., NOM adsorption reduced the short-term bactericidal effects of C60, Ag NPs, and Fe(0) NPs, but increased bioaccumulation).Some changes can theoretically restrict the persistence of NM in the environment (e.g., dissolution of Zn-O NPs). There is still a great deal of doubt about the role that changes play in both exposure and biological effects over the entire life cycle of NMs.

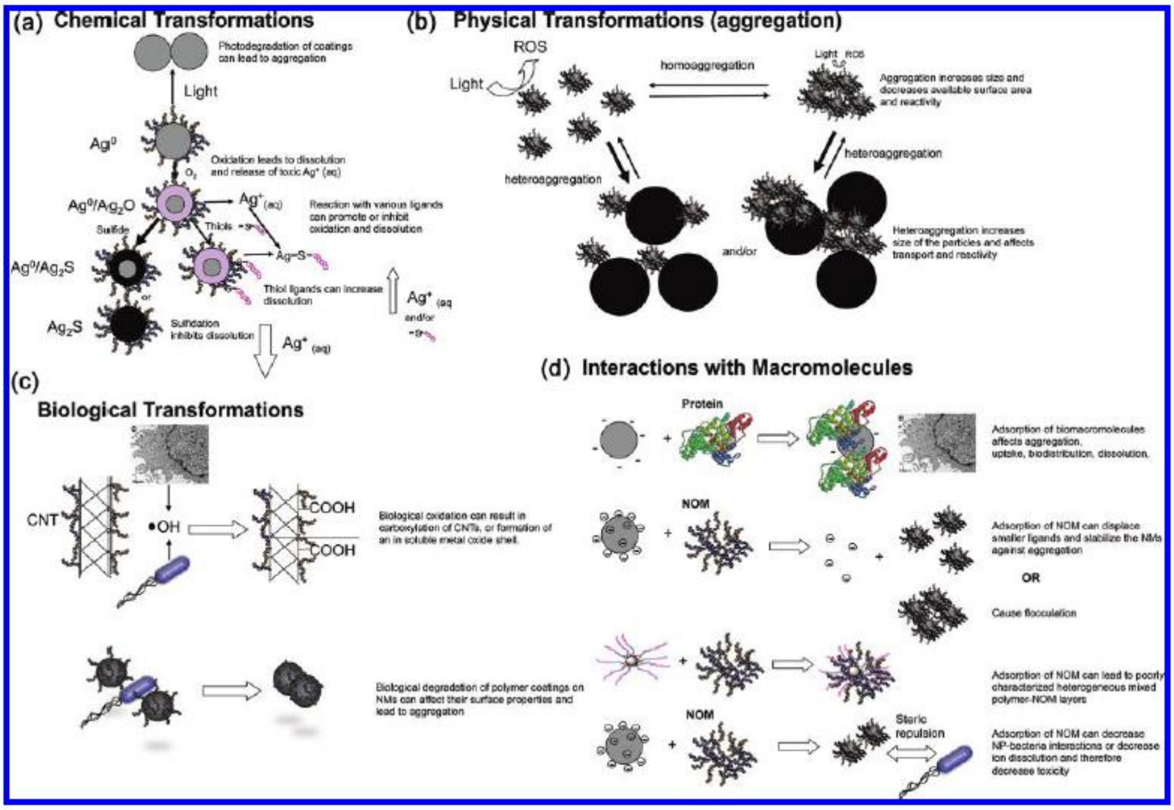

Figure 2: shows the effect of various factors on the Nanomaterials

II. CONCLUSION

In the environment and in vivo, transformations of NMs can easily occur, which greatly affect their properties, behavior, and effects. Most toxicity, destiny, and transport studies to date, however, have used relatively pristine materials that will behave differently from those that have been transformed.Although the results calculated for relatively pristine materials may be indicative of human exposures at manufacturing or processing sites where direct exposure to relatively pristine NMs is possible, environmental exposures to aquatic species and humans (e.g. via drinking water or food intake) would be to transformed NMs, so data on the fate and effects of pristine NMs will not be available. Instead, the research community needs to concentrate on understanding the reactivity, fate, mobility, persistence, and consequences of "aged" or transformed NMs where the "aging" phase better reflects the pre-exposure history of the NM.Exposures of NMs to the atmosphere are likely to be chronic and low in concentration. Therefore, to grasp the ultimate fate and distribution in the atmosphere and the potential for damaging effects, sluggish transformations of NMs would need to be evaluated. Some transformations, such as biomacromolecular adsorption or dissolution of metal NPs, are fundamental processes that affect both environmental and in vivo NM actions[10] Under relevant conditions, practically nothing is currently known about the rates of these transformations.Determining the ability and rates of these fundamental processes to occur should be a research priority since developments in this area would support many research groups in the field of nano EHS, such as fate and transport, toxicology and sustainable/green nanotechnology.For regulatory purposes, classifications of NMs are desirable[11]. Because most NMs are highly reactive, and since their fate and consequences are significantly influenced by these transformations, it may be possible to identify NMs, at least in part, by their predicted environmental transformations, although it will be difficult to integrate this into current legislation and regulatory practice. Depending on the setting in which they live, some NMs can require more than one classification. Transformations can result in materials that can be more heterogeneous than the parent NM, making it difficult to classify.However, if ubiquitous transformations (e.g. coating with humic acids, NOM or proteins, or sulfidation) lead to NMs with behaviors that are less affected by the NM core than by the coating, it is also possible that transformations can decrease heterogeneity. Ultimately, transformations and the characteristics of the transformed NM can depend on the setting they join and the order of the environments in which they are exposed. This reality, and the ambiguity about use and release scenarios, makes risk determination difficult

III. REFERENCES

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