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Consumers' Health and Safety in Relation to the Use of Nanotechnology in Food: Challenges and Perspectives From the Humanities and Social Sciences

Wilson Engelmann[a],*; Sandrine Gaymard[b]

[a]Department of Law, Universidade do Vale do Rio dos Sinos – UNISINOS, São Leopoldo, Brazil.
[b]Department of Psychology, University of Angers, Laboratoire de Psychologie des Pays de la Loire (LPPL) EA 4638, Angers, France.
*Corresponding author.

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Abstract

Nanotechnologies, which are a diverse set of technologies using the nanoscale equivalent to a billionth of a meter, enable the development of products with new features and functionalities. Among these there is the use of zinc nanoparticles in the food industry for the production of plastic containers and packaging to protect and transport food. There is scientific uncertainty about the safety of such use (avoiding food contamination for example), especially in regard to the coefficient of migration of the particles to the protected or transported food. There is no specific legislative regulatory framework, although in many countries there are standards from government agencies, signaling a new regulatory production without passing through conventional legislative process. Starting from a comprehensive approach to some articles of the Consumer Protection Code, the aim of this article is to devise regulatory options for structuring the "right to information" and the "duty to inform" under the "right to know" in a perspective of prevention and precaution.

Key words: Nanotechnologies; Risks; Zinc nanoparticles; Regulatory frameworks; Consumer law; Prevention; Precaution; Damage law.

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INTRODUCTION

Currently we live in a world where the motto is "innovation". There is a considerable and at times insurmountable distance from a buzzword to a truly innovative initiative that brings a combination of good ideas and human action. Thus, there is a gap between what innovation actually is and what is said to be innovative, but only represents a word, a discourse, without effects on human life in society and often with merely financial goals.

Nanotechnologies fall within this panorama; these are a growing set of technologies and sectors—related to research, industrial production and trade—that are developing products in the nanometer scale, which scale is equivalent to one billionth of a meter, corresponding to the atomic scale. It enables the manipulation of ultrafine particles and generates products with new physical and chemical characteristics. Although they are extremely small, they pose a big question because many of the effects generated by the interaction with the human body and the environment are still unknown. Despite the scenario of doubts, the products developed from these ultrafine particles—including food and packaging—are arriving in increasing quantities on the consumer market.

In answer to these questions, a temporary response suggested is anchored on the consumer's "right to information" and the manufacturer's "duty to inform",

as the two main parts in structuring a "Damage Law". This and the Consumer Law are the core elements of the "right to know", the corollary of the mentioned right/duty, which is based on a "connection between the heart and head". A reflection is sought concerning the legal and ethical impacts on the development of nanotechnology innovation.

1. A COMPREHENSIVE SCENARIO FOR NANOTECHNOLOGY: APPROACHES TO NAVIGATING THE NANOSCOPIC WORLD

Nanotechnology is in almost all productive sectors that are available today. What is contained in this word? The handling and production at the atomic scale, which mean the billionth part of a meter, equivalent to scientific notation 10^{-9}. According to the Technical Committee 229 of ISO (International Organization for Standardization, 2017), the use of nanoscale can be found in the following sectors such as: textiles, plastics, food packaging, building materials, medicines, sunscreens, medical and dental equipment, energy, sports equipment, military equipment and electronic devices.

The wider the use of the nanoscale in industry, the greater the amount of products offered to the consumer. Why the concern? Through specialized equipment, able to interact on the atomic level, are generated products with different physical and chemical characteristics from those found in its equivalent on the macro scale. Allied to this point, there is the non-existent specific regulation for nanotechnology throughout the life cycle of a nanomaterial. The Exact Sciences: Engineering, Chemistry, Physics, Biology and others, have not yet been able to calibrate the methodology for assessing the safety of products developed on the basis of nanoscale; the number of nanoparticles already produced by human action, the so-called engineered nanoparticles, is unknown.

Despite all this, there are already many products developed from the nanoscale—equivalent to between approximately 1 and 100 nanometers (nm). Figure 1 indicates the spectrum of options to pursue when researching nanotechnologies:

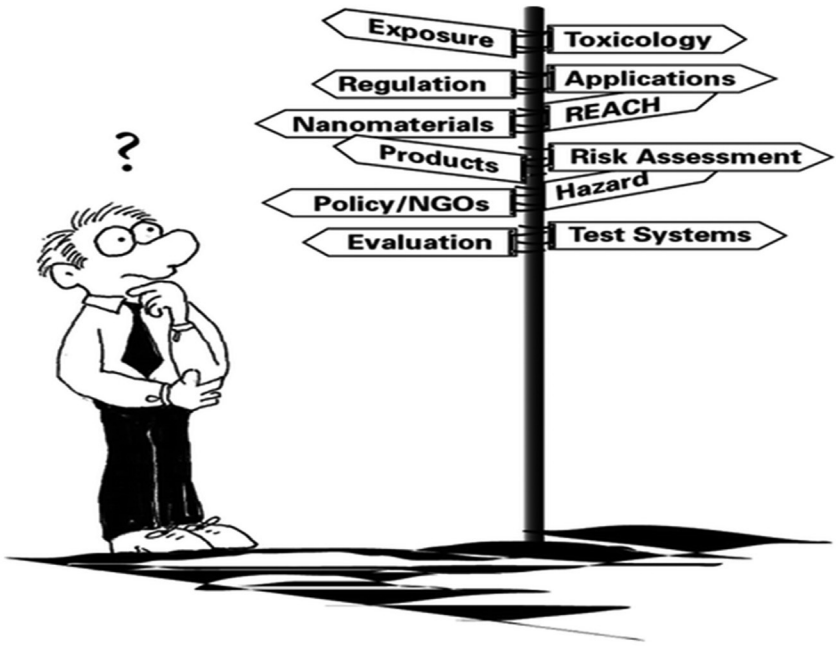

Figure 1
Options and Challenges for Nanotechnology Research
Source: Som et al., 2013.

The alternatives accessible to humans at a nanometer scale are diverse. In the case of toxicology, a new discipline, nanotoxicology (Oberdörster, 2014) has developed. A new discipline, this has failed to establish the operative parameters of the toxic effects that emerge from the interaction of nanoparticles with the environment and the human body. Therefore, there is still much research to be done in order to know the tolerable levels of exposure, especially for humans, and how to manage and assess the risks. It is important to draw the necessary elements for testing systems from each application of the nanoscale in the various sectors listed above. This will require close attention to the Law, which is responsible for regulation.

Permeating the various issues raised in the image above it is possible to highlight: the unusual properties of nanoparticles are mainly based on their size in nano scale and on their surface area. As the size of the particle

decreases and approaches the nanoscale, many properties begin to change compared to the same material in its macro size, as already mentioned. To give an example, in the nanoscale, the color and melting temperature of gold are very different from the conventional gold scale. The toxic effects of materials that appear as inert in the macro scale are also very different in the nanoscale. Because the particle surface area increases, a greater proportion of their atoms or molecules start to be displayed on the surface rather than within the material. There is an inverse relationship between particle size and the number of molecules present on the particle surface. The increase in surface area determines the potential number of reactive groups on the particle. The change of physical, chemical and structural properties of the nanoparticles with a decrease in size may be responsible for a number of material interactions that can lead to toxic effects. This gives rise to the scenario for nanotoxicology. These phenomena should be communicated to consumers. How can this be done? How can the technical language be transformed into understandable communication? These are issues that are not being adequately addressed by the companies that manufacture from the nanoscale and sell their products on the consumer market.

Article 31 of the Brazilian Consumer Protection Code (Brazil, 2017), for example, must be noted on the labels. That is, the consumer has the right to clear information in the Portuguese language, as well as to be informed about the possibility of some risk to their health or safety. The European Parliament (2009) also made mandatory, since July 2013, that cosmetic products must be labelled for their content of nanomaterials by adding (*nano*) after the substance name. However, this hardly ever occurs because it is not enough to say that the product is developed from nanotechnology, if the word is not part of consumers' daily lives. Furthermore, risks exist and are being deployed by scientific research published in qualified journals in various areas related to diverse nanomaterials such as carbon nanotubes and nanosilver. The latter is one of the most common engineered nanomaterials (those produced from human action) used in products for the consumer market. It has a significant antibacterial activity (Quiñones-Jurado, 2014) and low production cost. However, it presents toxicity mechanisms (Marques, 2013; Lee, 2007) an aspect that is not getting enough attention from the manufacturers or, at least, this "detail" does not appear on any label or advertising material. Nanosilver, for example, is used in the white line of domestic appliances, drinking fountains, air conditioners and other items of use and daily contact for the consumer.

These studies confirm the need to increase care for health and safety of humans and attention to the environment. The responses of Exact Sciences, which may also be referred to as Production Sciences (Gould, 2012), to date, are preliminary, inconclusive and often contradictory, but with evidence of risks, and they deserve the attention of the Impact Sciences. Here arises an interesting field for regulation, mobilizing the dialogue between the sources of Law, as a way of inserting the legal into the Nanotechnological Revolution scene.

2. THE CONSUMER'S RIGHT IN THE CONTEXT OF THE "RIGHT TO INFORMATION" AND THE "DUTY TO INFORM" GENERATED FROM NANOTECHNOLOGY

The article 31 of the Brazilian Consumer Protection Code (Brazil, 2017) presents itself as a vector for structuring the right to information, providing their substantial component elements. This article should be conjugated with Articles 8[1], 9[2] and 10[3] of the Brazilian Consumer Protection Code, drawing a special legal framework for the (secure) use of nanotechnologies, especially nanozinc in the utensils that come into contact with food. The consumer has the right to know if the packaging or the container in which the food was transported or packaged has zinc nanoparticles and the toxicological possibilities arising therefrom. For this right to be fully exercisable, the industry should provide the ongoing nanotoxicological investigations and the level of knowledge already existing at the beginning of the marketing.

Various stages of liability are at stake: One of them is of the packaging manufacturer; the other, of the manufacturer of the product, which uses the package. Both should communicate what they know, protecting the

[1] "Art. 8. The products and services offered in the consumer market do not bring risks to the health or safety of consumers, except those considered normal and predictable due to its nature and enjoyment, forcing the suppliers, in any event, to give the necessary and appropriate information about them. Sole paragraph. When it comes to industrial products, the manufacturer shall provide the information referred to in this article through the appropriate printings that must accompany the product". Retrieved 2015, February 25 from http://www.planalto.gov.br/ccivil_03/leis/l8078.htm

[2] "Art. 9. The supplier of products and services potentially harmful or dangerous to health or to safety must inform, conspicuously and appropriately, about its harm or hazard, subject to the adoption of other appropriate actions in each case". Retrieved 2015, February 25 from http://www.planalto.gov.br/ccivil_03/leis/l8078.htm

[3] "Art. 10. The supplier may not place a product or service that he knows or should know is heavily harmful or hazardous to health or safety in the consumer market. §1. The supplier of products and services, which after their introduction in the consumer market, is aware of the danger they present, should report it immediately to the competent authorities and to consumers through advertisements. §2. The advertisements referred to in the previous paragraph will be revealed in the press, radio and television, at the expense of the supplier of the product or service. §3. Whenever they become aware of products or services dangerous to the health or safety of consumers, the Federal Government, the states, the Federal District and the municipalities should inform them about it". Retrieved 2015, February 25 from http://www.planalto.gov.br/ccivil_03/leis/l8078.htm

most confidential information that may be protected by industrial property. A special combination occurs between Articles 8 and 9, as both highlight the need to inform what is known so far. This includes a basic manufacturer's duty to point out that it is a product and / or packaging that has nanoparticles, presenting, therefore, as it was seen earlier, different characteristics from conventional packages.

The "*caput"* of article 10 is even more incisive because it imposes a fundamental duty on the manufacturer in the form of a prohibition. A product or service cannot be put on the consumer market when some degree of harmfulness or danger to health or to safety is "known" or "should be known". This means that, through the four articles of the Consumer Protection Code, Brazilian law brought together several levels of discussion now in progress. The wording of the two paragraphs of article 10 also points to a need to continue the research into products on the consumer market. The entrepreneur must inform about the new scientific discoveries concerning their products and needs to invest in research covering the product after-sales by opening channels of communication with the consumer.

Along with this set of the Brazilian Consumer Protection Code devices is article 931[4] of The Civil Code, a new introduction brought by the 2002 Code, when presenting the *risk of development*. Beyond defects, the entrepreneur is accountable for products placed on the consumer market. The dialogue between the sources indicates the legislative intent: the marketing of any product should take into account health and consumer safety, and consequently, the environment. Nanoscale-based products, which now exist in quantity and quality in modern society, are not prohibited from being marketed providing that they clearly inform on the label or in other media. At the same time the entrepreneur must keep searching if he does not have scientific certainty (and this is increasingly uncertain) about the possible risks of the product to human beings and to the environment.

An alternative to promote information can be noted in the insertion of the yellow triangle with the letter "N" in the center and an "x", written in the lower case, referring to a part of the label where the entrepreneur shows where and in what quantity the nanoparticle was used in the product:

Source: Lima, 2015.

[4] "Art. 931. Except in other cases provided by special law, individual entrepreneurs and companies respond regardless of fault for damage caused by products put into circulation". Retrieved 2017, February 25 from http://www.planalto.gov.br/ccivil_03/leis/2002/l10406.htm

It's a small step for consumers, themselves beginners in the knowledge of nanotechnologies and their impact on consumer products, including food.

As to the concern to inform consumers about the product they are consuming, there is a research project being developed by several research institutes belonging to European countries, seeking to build a *good practice guide on packaging*: the concept of "*NanoSafePack"*. This arises from the need to ensure the safety of workers who handle nanoparticles and to make sure that the nanocomposites introduced into the market are safe in accordance with the European regulations, in order to avoid endangering consumers' health and the environment (NanoSafePack, 2017). It is important to say that if the packaging and its contents meet these requirements, the ethical basis of nanotechnological innovation is assured. Without this, the characterization of an actual "innovation" should be questioned.

The *good practice guide* is presented as a form of regulation to be inserted in the context of *rule of law*. There is no need to wait for the state legislative command but it will be essential to act through the principle of precaution. This is the challenge brought to Law by the nanoscale: To reinvent the General Theory of Sources of Law, seeking to tune them to the new social needs created by the advance of technology. It is not possible to wait for the legislative process, although democratic. It is essential for democracy to be a value that supports flexible production rules and attuned to the rapid advances generated within globalized society. It cannot be forgotten that, as a radiant value and at the same time as a founding axle of the Democratic State of Law in Brazil, democracy requires the mobilization of everyone involved (and affected) by the positive and negative effects that nanotechnology may also generate.

Thus, the "right to know" as a complementary right to the "right to information" (which all the company's members hold, as workers and/or as consumers), is generated along with the "duty to inform" of those who hold the information. This is in its beginnings and includes everyone from the researcher to the marketer, passing through the supplier and the industry. This is the main point of the emergence of "shared responsibility", which is in the National Solid Waste Policy, ensuring: a "shared responsibility for the lifecycle of the product [is the] set of individualized and linked responsibilities of manufacturers, importers, distributors and traders, consumers and owners of public services for urban cleaning and solid waste management, as to minimize the volume of waste disposal and waste generated as well as to reduce the impacts to human health and environmental quality resulting from the life cycle of products under this Act; [...]" (Brazil, 2017a). Here you have a chain of social actors who should be responsible for the assessment and management of risks that may be generated from the

nanoscale. They are the ones that produce the symbiosis between the right and the duty to inform and be informed.

Over the nanomaterial lifecycle there will always be someone generating information and someone seeking this information in order to guide its entry into the lifecycle. The consumer has the right to know, before joining one of the accountability steps; it is the responsibility of the other members (article 3, XVII), people with different sides of the information, to provide it with quality—then democracy—thus allowing a good choice to the consumer. The movement which is established in this true chain of "responsibilities" that should be considered when structuring the "Damage Law", understood as a set of

> [...] mechanisms to avoid the damage by preventing—facing an activity whose harmful consequences are known or—precautionary—facing an activity whose consequences are not known— to ensure effective protection of individual rights and safeguard to their previous state. (Cossari, 2014)

The innovations brought about by nanotechnology can be inserted in that framework, that is, the main aspect is not to wait for the occurrence of the damage, in order to establish the compensation, no matter how complete and extensively it can be calculated. It is time to structure a preventive and precautionary direction, considering that a number of risks and consequences have already been demonstrated scientifically.

By the aspects seen, there is strong scientific evidence of the following: "[...] Executives need to understand that a new paradigm for doing business will require fundamental changes in thinking, behavior and business models" (Nidumolu, Kramer, & Zeitz, 2012). The proposed change to executives should also apply to jurists in order to seek ways of thinking that can be put in place of the still dominant positivist paradigm of legalistic basis. There will be no social and political space to build the state legislative framework, considering the speed of the emergence and transformation of techno-scientific innovations generated by nanotechnology. The challenge is to "connect" scientific and technological innovation to an ethical foundation (Forsberg, 2015). This is the way to regulate the innovations and challenges posed by nanotechnology, without depending on state legislative action, but linking the normative production of various actors, some of whom were studied in the first two parts of this text. This is not to remove the role of the State or the intervention of its powers, but to open creative and flexible legal possibilities to the "juridization" of nanotechnological social facts, working in a preventive-precautionary way (Engelmann & Von Hohendorff, 2015).

3. A MULTIDISCIPLINARY APPROACH

According to Luhmann (1990), a systemic-functionalist perspective is intended to establish the link between the problem and a solution to be built, notably by observing the regulatory frameworks able to cope with the challenges posed by nanotechnology. This method promotes the development toward multidisciplinarity because it imposes a dynamic that seeks to deal with action on various levels of reality, from different semantics. So that the Law can deal with the challenges brought by the advances in nanotechnology, two paths will have to be opened: include other areas of knowledge that may help to understand the complexity of the realities that nanotechnology will allow and enable the entrance of ideas from other areas and knowledge. A national and foreign doctrinal research on the investigated topic will be made, with content analysis (Bardin, 2011), as well as regulations already issued on nanotechnology, signaling how adequate regulatory frameworks in line with the Brazilian Consumer Protection Code can be structured through critical analysis. Gaymard and Engelmann (2016) proposed a dual reading from the social psychology and legal points of view revealing the interest of complementarity in new lights in Human and Social Sciences. An exploratory study about the social representation of nanotechnologies performed with Humanities and Social Sciences (HSS) students *vs* Exact Science (ES) students shows how this object is appropriated in relation to the students' field of study. Social psychology and law belong to what is known as "Sciences of impact" whose role is to reflect on the challenges and impacts of nanotechnologies in the social, human, legal, political, and economic fields. If legislation is a capital aspect in the field of nanotechnologies, social representation takes account of appropriation by social groups and in the field of risk it is known that this appropriation also has a defensive and protective role (Gaymard, 2012; Gaymard, Kay, & Etoundi, 2015). Human and Social Sciences constitute the necessary relay between the development of nanotechnologies and the ethical and social aspects inherent in this development (Gaymard & Engelmann, 2015).

CONCLUSION

This article underlines certain possibilities through nanotechnology, especially the use of zinc nanoparticles, given their antibacterial potential. Therefore, it is shown as an important ally in packaging and plastic boxes that store and transport food. There are doubts about the percentage of these particles that may migrate into food, thus affecting the food's safety. The information gathered points to both sides: The positive and the negative, which highlights the need for more research before this nanoparticle can be used in the food industry.

There emerges here the necessity to trigger the so-called "good practices", that is the actions of prevention and precaution, based on the foundations of the Constitution of Brazil, especially in the areas of health, safety (workers and consumers) and the environment.

From the focus shown by the constitution text, the aim was to show the possibility of connection between some rules of the Consumer Protection Code and the Civil Code. Reflection was sought on the elements of a "Damage Law", with concern about the non-occurrence of damage, given the difficulty of repairing and returning to the previous state. It is crucial to enable the full exercise of the right of the consumer to information. This will require structural and responsible building of the duty of information by the researcher, manufacturer and trader, showing the relevance of "shared responsibility" (National Policy of Solids Waste) among all those who are involved in the life cycle of a nanomaterial. To project for the future, humanizing globalization centers around three objectives: to resist dehumanization, hold their actors responsible and anticipate future risks. The key elements confirmed to guide decision-making are: humanism, thus ethical concern, highlighting the presence of human beings and of environmental issues. These come together to form the essence of Human Rights; everyone involved should take their part of responsibility that is shared and no one can evade it, hence the necessity to know more about the risks carried by nanoparticles. Warning: no one is proclaiming a moratorium on the use of the nanoscale, but the use of good practices at all stages of the development cycle of products based on nanotechnology.

REFERENCES

Bardin, L. (2011). *Content analysis* (L. A. Reto, Trans.). Augusto Pinheiro. São Paulo: Edições 70.

Brazil. (2017). *Brazilian consumer protection code*. Retrieved February 25 from http://www.planalto.gov.br/ccivil_03/leis/L8078.htm

Brazil. (2017a). Law 12.305, of August 2, 2010, that established the *national policy on solid waste*; amending Law n.9.605, of February 12, 1998; and other measures. Retrieved February 25 from http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/lei/l12305.htm

Cossari, M. N. G. (2014). La need to prevención of daños before them limits del clásico régimen Argentine reparación. *Revista de Derecho*, *Facultad de Derecho de la Universidad Católica del Uruguay, 9*(10), 13-40.

Engelmann, W., & Von Hohendorff, R. (2015). *The management of risks by the Law in the nano agrochemicals scenario*. Germany: Lambert Academic Publishing.

European Parliament and the Council. (2009). *Regulation (EC) n. 1223/2009 of the European parliament and the council of 30 November 2009 on Cosmetic Products* [Internet]. Retrived February 25 from http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:342:0059:020:en:PDF

Forsberg, E.-M. (2015). ELSA and RRI—Editorial. *Life Sciences, Society and Policy, 11*(2). Retrieved February 25 from http://www.lsspjournal.com/content/11/1/2

Gaymard, S. (2012). Pedestrian representation through the analysis of little stories. *Psychology of Language and Communication, 16*(3)*,* 185-200. doi: 10.2478/v10057-012-0013-9

Gaymard, S., & Engelmann, W. (2015). *Societal and human aspects, nanomedicine and law: Challenges to the appropriate treatment of nanowaste*. 4th NanoFar Autumn School, Nantes (26-30 October).

Gaymard, S., & Engelmann, W. (2016). Nanotechnologies, risks and societal concerns. *Modern Applied Science*, *10*(10). Retrieved from http://dx.doi.org/10.5539/mas.v10n10p241

Gaymard, S., Kay, N., & Etoundi, J. C. (2015). Climate change and beliefs in Cameroon: A qualitative study among farmers in the Equatorial and Sudano-Sahelian zones. *Canadian Social Science*, *11*(7), 53-64. doi: 10.3968/7273

Gould, K. (2012). Unsustainable science in the treadmill of production: The declining salience of impact science in environmental conflicts. *Denver American Sociological Association.* Retrieved February 25 http://www.allacademic.com/meta/p.564435_index.html

International Organization for Standardization (ISO). (2017). *TC 229*. Retrieved February 25 http://www.iso.org/iso/iso_technical_committee?commid=381983

Lee, K. J., et al. (2007). *In vivo* imaging of transport and biocompatibility of single silver nanoparticles in early development of zebrafish embryos. *American Chemical Society Nano, 1*(2), 133-143.

Lima, E. G. (2015). Developed symbol to identify products containing nanotechnology. Retrieved February 25 http://noticias.r7.com/dino/economia/desenvolvido-simbolo-para-identificar-produtos-contendo-nanotecnologia-27052015

Luhmann, N. (1990). *Sociedad y system.* Traduction Santiago López Petit and Dorothee Schmitz. Barcelona: Paidóis.

Marques, B. F., et al. (2013). Toxicological effects induced by the nanomaterials fullerene and nanosilver in the polychaeta *Laeonereis acuta* (Nereididae) and in the bacteria communities living at their surface. *Marine Environmental Research*, 89, 53-62.

NanoSafePack. (2017). *Safe Handling and Use of Nanoparticles in Packaging*. Retrieved February 25 http://www.nanosafepack.eu/

Nidumolu, R., Kramer, K., & Zeitz, J. (2012). Connecting heart to head. *Stanford Social Innovation Review, 10*(1), 42-47.

Oberdörster, G. (2014). *Nanotoxicology*. 7th International Nanotoxicology Congress, NanoTox, Antalya–Turkey (23-26 April).

Quiñones-Jurado, Z. V., et al. (2014). Silver nanoparticles supported on TiO_2 and their antibacterial properties: Effect of surface confinement and nonexistence of plasmon resonance. *Materials Sciences and Applications, 5,* 895-903.

Som, C., et al. (2013). Toward the development of decision supporting tools que can be used for safe production and use of nanomaterials. *Accounts of Chemical Research, 46*(3), 863-872.