The Use *of* Nanomaterials in Food Contact Materials

Design, Application, Safety

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DES*tech* Publications, Inc.

The Use of Nanomaterials in Food Contact Materials

DEStech Publications, Inc.
439 North Duke Street
Lancaster, Pennsylvania 17602 U.S.A.

Printed in the United States of America
10 9 8 7 6 5 4 3 2 1

Main entry under title:
The Use of Nanomaterials in Food Contact Materials: Design, Application, Safety

A DEStech Publications book
Bibliography: p.
Includes index p. 384

Library of Congress Control Number: 2017932593
ISBN No. 978-1-60595-136-2

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CHAPTER 1

Introduction

ROB VERAART

THE use of nanomaterials has been a hot topic for several decades. However, nanomaterials are not new. They have existed as long as the earth has existed but in the perception of many people, nanomaterials are regarded as new materials. Nanomaterials are not typical man-made substances. They can be found in many non-man-made materials/substances such as clay, smoke, etc. There has been an increasing interest in using nanomaterials in a variety of products over the last decades, but many people don't know that some of the nanomaterials have been in production for some time. Now, more and more nanomaterials are being developed by the industry because nanomaterials have much different and beneficial characteristics compared with the non-nano version of the same material. This means that existing products can be improved by including new characteristics or by improving existing characteristics.

The new developments in the production and use of nanomaterials are the result of efforts by both the industry and universities. These new developments are stimulated by various governmental and European Union (EU)-based projects. The legislation on the use and safety of nanomaterials is somewhat lagging on these developments. The legislation on consumer products as well as nonconsumer products regards nanomaterials only recently as a special class of materials. This book discusses various aspects of the use of nanomaterials in food contact materials. Further, this book focuses on the effects of the consumer who is ultimately consuming the food that has been in contact with with nanomaterials.

A wide variety of aspects on the use of nanomaterials in food contact materials is discussed. As a start, some examples of (potential) uses of nanomaterials in food contact materials are discussed in Chapters 2–5.

Food contact materials are heavily regulated in most countries for obvious reasons. The legislation is still in development regarding the use of nanomaterials. Especially in Europe; there are many initiatives by the EU as well as on the Member State level, as discussed in Chapters 6 and 7. The current legal status in other parts of the world is discussed in Chapters 8–10.

A good definition of nanomaterial is crucial because definitions in the legislations determine which materials are in the scope of the legislation and which materials are outside of the scope. The problem, however, is that it is difficult to define nanomaterials. Despite the fact that many efforts are being made to define which substances are regarded as nanomaterials and which one not, many definitions exist in the industry and in various legislations. Nanoparticles exist in many different forms and shapes: tube-shapes, irregular particles, spherical particles, plate-like particles, etc. In addition, the particles can consist of many different molecules: only carbon, carbon with hydrogen and other molecules, or completely inorganic. This makes it not easy to set a one size fits all definition for nanomaterials. Therefore, nanomaterials are often defined by particle size boundaries. However, the size only does not determine whether a material has specific size-related properties. In addition to this, size is not a well-defined parameter. For a perfect solid sphere there are already differences in particle sizes depending on which analytical technique is used. Some of the techniques will include a small layer of solvent around the particle while others do not. For particles that do not have a perfect sphere it is even more complicated. Some techniques determine the size of the particle at a given moment, other techniques determine an average size over time. This gives some issues as definitions are used in the legislation to define which substances are to be regarded as nanomaterials (and as a result may be exposed to additional requirements) or are regarded as “normal” substances.

As will be discussed in the book, the size is often the important factor in the definition as used in various legislations. In addition, other characterizations are important as well. These characteristics are important in the risk assessment of nanoparticles. Therefore, these three parameters, (size determination, non-size characterization, and toxicology) are extensively discussed in Chapters 11–13. Nanomaterials are often presented as very small substances. This is true if you compare the size

of a nanomaterial with objects you normally see. However, the typical 1 nm–100 nm range (which is often used) covers many larger molecules. Here are some examples of sizes of molecules to put the 1 nm–100 nm in perspective. A molecule such as sucrose, which is not a very big molecule, is just smaller: 0.9 nm. Proteins that are normally in the 1 nm–100 nm range: an albumin protein molecule (with a molecular weight of 65,600 Da) has a size of 15 nm long and a radius of 3.48 nm (Perry, 1994) and a hemoglobin protein (with a molecular weight of 64,000 Da for the four subunits together) has a radius of 6.8 nm (Acharya *et al.*, 2005). Cell membranes are about 6.8 nm.

One important factor for food contact materials is that exposure to nanomaterials by the consumer can only be achieved by oral intake. However, before a nanoparticle (originating from the packaging) can be eaten with the food, it has to migrate from the food contact material to the food. The migration is discussed in Chapters 14 and 15. The potential migration can be determined by either measurements using a variety of analytical methods but also using calculations mathematic modelling. Both methods are extensively discussed. Nanomaterials are due to the large size virtually immobilized in the polymer, and migration of nanomaterials can be regarded as not significant. Combined with the toxicological fact that no exposure means no risk, it can be concluded that the risks of eating food that has been in contact with food contact materials containing nanomaterials is minimal.

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