Nanotechnologies for Future Mobile Devices

Learn how nanotechnologies, mobile communication, and the Internet are related to each other, and explore the potential for nanotechnologies to transform future mobile and Internet communications and the value networks of future electronics manufacturing. Based on a research collaboration between Nokia, Helsinki University of Technology, and the University of Cambridge, here leading researchers and business analysts review the current state-of-the-art and future prospects for:

- Structural materials in mobile devices, including novel multifunctional materials, dirt-repellent, self-healing surface materials, and lightweight structural materials capable of adapting their shape.
- Portable energy storage using supercapacitor-battery hybrids based on new materials including carbon nanohorns and porous electrodes, fuel cell technologies, energy harvesting, and more efficient solar cells.
- Electronics and computing advances reaching beyond IC scaling limits, new computing approaches and architectures, embedded intelligence, and future memory technologies.
- Nanoscale transducers for mechanical, optical, and chemical sensing, nature's way of sensing and actuation, biomimetics in sensor signal processing, and nanoscale actuation.
- Nanoelectronics, for example based on graphene, to create ultrafast and adaptive electronics for future radio technologies, such as cognitive radio.
- Flat panel displays – how nanotechnologies can be used to achieve greater robustness, improved resolution, brightness and contrast, as well as mechanical flexibility.
- Open innovation in nanotechnology development, future manufacturing, and value networks.
- Commercialization of nanotechnologies.

Tapani Ryhänen is Laboratory Director of Nokia Research Center, heading Nokia's research laboratories in Cambridge and Lausanne. He is also responsible for Nokia's research collaboration with the University of Cambridge and the Ecole Polytechnique Fédérale de Lausanne (EPFL), and he is a Visiting Lecturer at the University of Cambridge.

Mikko A. Uusitalo is Principal Member of Research Staff at Nokia Research Center, Helsinki, where he has worked since 2000. He is a Founding Member of the Wireless World Research Forum (WWRF) and EUREKA CELTIC Initiative, and he is a Senior Member of the IEEE.

Olli Ikkala is Academy Professor of the Academy of Finland and Professor of Polymer Physics and Molecular Nanostructures at the Helsinki University of Technology. His current research interest is in developing concepts for functional nanomaterials based on macromolecules, synthetic polymers, and biomacromolecules.

Asta Kärkkäinen is Principal Scientist at Nokia Research Center, Helsinki, where she has worked since 1997. As a Research Manager of the Predictive Engineering Group, she has coordinated research on multidisciplinary design to enable optimal structural, thermal, acoustical, and chemical performance of future Nokia devices.

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Edited by

TAPANI RYHÄNEN
Nokia Research Center, Cambridge

MIKKO A. UUSITALO
Nokia Research Center, Helsinki

OLLI IKKALA
Helsinki University of Technology

ASTA KÄRKKÄINEN
Nokia Research Center, Helsinki

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Contents

List of contributors

Gehan Amaratunga
University of Cambridge

Piers Andrew
Nokia Research Center

Marc Bailey
Nokia Research Center

Alan Colli
Nokia Research Center

Tom Crawley
Spinverse Ltd

Vladimir Ermolov
Nokia Research Center

Andrew Flewitt
University of Cambridge

Christian Gamrat
CEA-LIST

Markku Heino
Nokia Research Center

Olli Ikkala
Helsinki University of Technology

Laura Juvonen
Spinverse Ltd

Risto Kaunisto
Nokia Research Center

Jani Kivioja
Nokia Research Center

Pekka Koponen
Spinverse Ltd

Asta Kärkkäinen
Nokia Research Center

Finbarr Livesey
University of Cambridge

William Milne
University of Cambridge

Tim Minshall
University of Cambridge

Letizia Mortara
University of Cambridge

Johann Napp
University of Cambridge

Pirjo Pasanen
Nokia Research Center

Aarno Pärssinen
Nokia Research Center

Markku Rouvala
Nokia Research Center

Mikko A. Uusitalo
Nokia Research Center

Tapani Ryhänen
Nokia Research Center

Di Wei
Nokia Research Center

Yongjiang Shi
University of Cambridge

Yufeng Zhang
University of Cambridge

Preface

Human culture is simultaneously extending its capabilities to master the physical world at its molecular scale and to connect people, businesses, information, and things globally, locally, and pervasively in real time. Nanotechnologies, mobile communication, and the Internet have had a disruptive impact on our economies and everyday lives. Nanotechnologies enable us to use physical, chemical, and biological processes to create new functional materials, nanoscale components, and systems. This book explains how these technologies are related to each other, how nanotechnologies can be used to extend the use of mobile communication and the Internet, and how nanotechnologies may transform future manufacturing and value networks.

At the beginning of 2007, the University of Cambridge, Helsinki University of Technology, and Nokia Research Center established a collaboration in nanotechnology research according to open innovation principles. The target has been to develop concrete, tangible technologies for future mobile devices and also to explore nanotechnologies in order to understand their impact in the bigger picture. The collaboration is based on joint research teams and joint decision making. We believe that this is the proper way to build a solid foundation for future mobile communication technologies. The book is based on the visions of researchers from both academia and industry.

During the summer of 2007 a team of researchers and industrial designers from the University of Cambridge and Nokia created a new mobile device concept called Morph. The Morph concept was launched alongside the "Design and The Elastic Mind" exhibition at the Museum of Modern Art (MOMA) in New York, has been featured in several other exhibitions, won a prestigious *reddot* design concept award, and has had considerable publicity – especially in the Internet. To date, the concept has been viewed over three million times on YouTube. The story of Morph illustrates how nanotechnologies are linked to our everyday artifacts and our everyday lives. In our messages we have always emphasized realism and the responsible introduction of these new technologies to future products. We need to understand thoroughly both the opportunities and risks.

The public interest in the Morph concept may be related to the concreteness of everyday nanotechnology applications illustrating tangible, appealing consumer benefit and value. If the story of Morph was directed to a wider audience, this book is targeted at researchers and people creating future technology and business strategies in both industry and academia. However, we still emphasize the two issues, concreteness and consumer value. Our target has not been to write a comprehensive textbook or a review of nanotechnologies for future mobile devices but through selected examples to illustrate

the impact on key mobile device technologies, manufacturing, value networks, innovation models, and ultimately on human societies. Our approach is also critical: sometimes the impact of a new technology is not straightforward and needs to be evaluated against competing technologies that may already be commercially available.

This is a vision statement of academic and industrial researchers working together in the spirit of open innovation. We hope that our book helps to promote stronger links between people working in different fields creating future concepts of mobile communication, Internet services, and nanotechnologies.