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EDITORIAL

Nano as a Rosetta Stone: The Global Roles and Opportunities for Nanoscience and Nanotechnology

As we have for the last six years, nano center directors and leaders in nanoscience and nanotechnology from around the world met in Beijing, the day before ChinaNano.[1−3] We shared our experiences on how our fields are perceived by our colleagues, institutions, countries, the public, and each other. We discussed our goals and strategies—where we are headed and how we interact with others in and beyond our fields. Here, we report some of the highest level issues that we face around the world. We also highlight some of the interesting areas now being explored at nano centers.

An overarching comment, and the title feature here "Nano as a Rosetta Stone", is that nanoscience and nanotechnology connect fields together. As nanotechnology has grown as a field, we have taught each other approaches and languages, taken on each other's problems, and have developed new capabilities, tools, and methods to explore existing and newly uncovered opportunities. Nanoscientists were key to developing the BRAIN Initiative in the U.S.,[4] its partner efforts in other countries, and the microbiome initiatives around the world.[5] Among the many new efforts being explored in nano centers are the nanoscale and larger contributions to the origins of life, developing world research and applications in and for nano, how nanotechnology can contribute to the UN Sustainable Development goals,[6] and more.

We often return to the idea that the nanoscale is the scale of function in biology. The consequences are that the tools and materials that we develop can give us new insights into the biological world. It also means that the interactions between nanomaterials and biological systems can be strong, with important consequences in both medicine and environmental health and safety. One point that came up repeatedly was that, given the unlimited variety of nanomaterials that are accessible, it should be possible to defeat the threat of drug resistance by coming up with materials to which pathogens and diseases have not previously been exposed. Nanomedicine continues to grow as a research field, but moving to the clinic requires significant efforts to pass through regulatory approval. Taking this important step into account early in the design of nanomedicines can significantly improve the likelihood of real impact in medicine.

In the areas of nanomaterials and devices, exciting new and hybrid materials with newly discovered and extraordinary properties open a world of possibilities. How new devices will be constructed and integrated into or even displace existing technologies all remain open questions. Again, we will draw on our expertise in and connection to many fields to address these issues. In some cases, the production of nanomaterials has already been scaled up and will rival that of conventional materials. For example, carbon nanotubes, which were relatively recently considered exotic materials, are now produced at the scale of hundreds of tons per year and widely used in Li-ion batteries.

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The group had divergent views on how and whether to formalize education in nanoscience and nanotechnology.[7] A number of nano centers are establishing linkages and exchanges as a way to cross-pollinate ideas and to share best practices.

Prof. Yuliang Zhao, director of the National Center for Nanoscience and Technology, at the Nano Center Directors' Forum, discussing how to engage the public by describing the nanotechnology we use every day in our devices. Photo credit: National Center for Nanoscience and Technology.

We also looked at how we can engage the public and our decision makers.[8] Although support for nanoscience and nanotechnology varies from country to country, as we do not have a formal worldwide organization such as the American Chemical Society, it is incumbent upon us and our colleagues to make the case for the importance of our field. We find no equivalent "Rosetta Stone" arising in other fields that could replace our efforts, so it remains to us to connect fields

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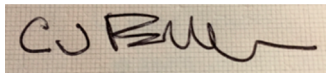
together and to foster new interdisciplinary areas, such as the quantum initiatives that are being set up around the world.

We look forward to hearing your thoughts and activities in how you see the future of nanoscience and nanotechnology, and how we might engage the public, our governments, our colleagues, and each other.

Yuliang Zhao, Editorial Advisory Board

Chunli Bai, Editorial Advisory Board



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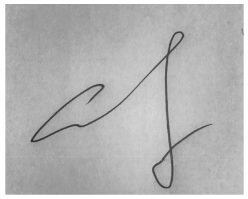

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AUTHOR INFORMATION

Corresponding Author
*E-mail: editor@nano.ucla.edu.

ORCID
Yuliang Zhao: 0000-0002-9586-9360
C. Jeffrey Brinker: 0000-0002-7145-9324
Lifeng Chi: 0000-0003-3835-2776
Kenneth A. Dawson: 0000-0002-0568-6588
Yury Gogotsi: 0000-0001-9423-4032
Naomi J. Halas: 0000-0002-8461-8494
Shuit-Tong Lee: 0000-0003-1238-9802
Takhee Lee: 0000-0001-5988-5219
Luis Liz-Marzán: 0000-0002-6647-1353
Sushanta Mitra: 0000-0003-0792-8314
Andre E Nel: 0000-0002-5232-4686
Peter Nordlander: 0000-0002-1633-2937
Wolfgang J Parak: 0000-0003-1672-6650
Andrey L. Rogach: 0000-0002-8263-8141
Vincent M. Rotello: 0000-0002-5184-5439

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Ben Zhong Tang: 0000-0002-0293-964X
Andrew T. S. Wee: 0000-0002-5828-4312
Paul S. Weiss: 0000-0001-5527-6248

Notes

Views expressed in this editorial are those of the authors and not necessarily the views of the ACS.

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■ REFERENCES

(1) Mulvaney, P.; Nel, A. E.; Rogach, A.; Weiss, P. S. Nanocenter Directors Gather from around the World. *ACS Nano* **2013**, *7*, 7437−7438.

(2) Hersam, M. C.; Lee, S. T.; Nel, A. E.; Rogach, A.; Buriak, J. M.; Weiss, P. S. Big Roles for Nanocenters. *ACS Nano* **2015**, *9*, 8639−8640.

(3) Liu, M.; Bai, C.; Antonietti, M.; Lynch, I.; Mirkin, C. A.; Khademhosseini, A.; Lee, S.-T.; Möhwald, H.; Rogach, A. L.; Wee, A. T. S.; Weiss, P. S. Connecting Together Nanocenters around the World. *ACS Nano* **2017**, *11*, 8531−8532.

(4) Alivisatos, A. P.; Andrews, A. M.; Boyden, E. S.; Chun, M.; Church, G. M.; Deisseroth, K.; Donoghue, J. P.; Fraser, S. E.; Lippincott-Schwartz, J.; Looger, L. L.; Masmanidis, S.; McEuen, P. L.; Nurmikko, A. V.; Park, H.; Peterka, D. S.; Reid, C.; Roukes, M. L.; Scherer, A.; Schnitzer, M.; Sejnowski, T. J.; et al. Nanotools for Neuroscience and Brain Activity Mapping. *ACS Nano* **2013**, *7*, 1850−1866.

(5) Biteen, J. S.; Blainey, P. C.; Cardon, Z. G.; Chun, M.; Church, G. M.; Dorrestein, P. C.; Fraser, S. E.; Gilbert, J. A.; Jansson, J. K.; Knight, R.; Miller, J. F.; Ozcan, A.; Prather, K. A.; Quake, S. R.; Ruby, E. G.; Silver, P. A.; Taha, S.; van den Engh, G.; Weiss, P. S.; Wong, G. C. L.; et al. Tools for the Microbiome: Nano and Beyond. *ACS Nano* **2016**, *10*, 6−37.

(6) https://www.un.org/sustainabledevelopment/sustainable-development-goals/ Accessed October 9, 2019.

(7) Jackman, J. A.; Cho, D.-J.; Lee, J.; Chen, J. M.; Besenbacher, F.; Bonnell, D. A.; Hersam, M. C.; Weiss, P. S.; Cho, N.-J. Nanotechnology Education for the Global World: Training the Leaders of Tomorrow. *ACS Nano* **2016**, *10*, 5595−5599.

(8) Kagan, C. R.; Fernandez, L. E.; Gogotsi, Y.; Hammond, P. T.; Hersam, M. C.; Nel, A. E.; Penner, R. M.; Willson, C. G.; Weiss, P. S. Nano Day: Celebrating the Next Decade of Nanoscience and Nanotechnology. *ACS Nano* **2016**, *10*, 9093−9103.

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