



Professor Chad A. Mirkin
George B. Rathmann Professor of Chemistry, Medicine, Materials
Science & Engineering, Biomedical Engineering, Chemical &
Biological Engineering,
Northwestern University
USA

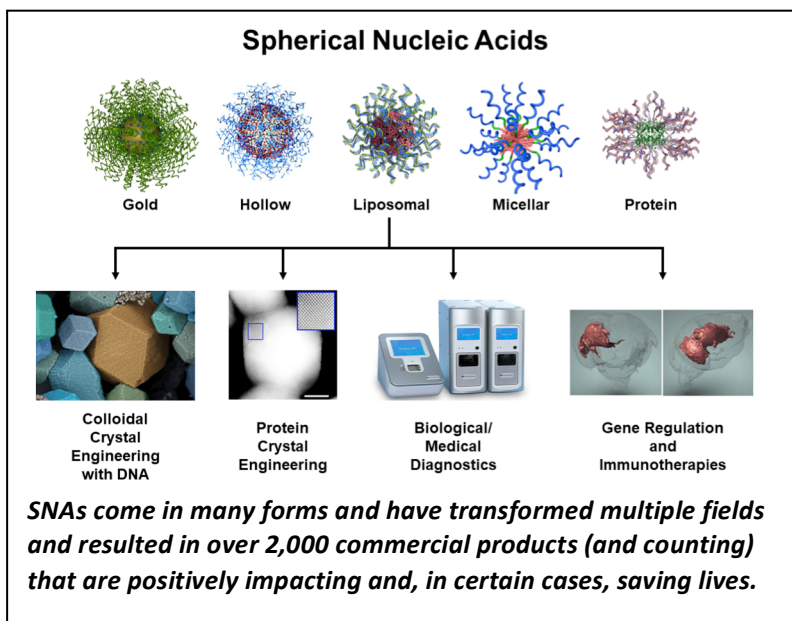
December 8, 2017

Albert Einstein Award Committee
The World Cultural Council
wcc@prodigy.net.mx

Dear Selection Committee

It gives me immense pleasure to nominate **Professor Chad A. Mirkin** of Northwestern University for the Albert Einstein World Award of Science *for his discovery and development of spherical nucleic acids (SNAs), chemically well-defined nanostructures that have changed the way we think about DNA and RNA and formed the cornerstones of new fields and technologies that are impacting a multitude of scientific disciplines.* This award is given to those individuals, who “open a door” by profoundly changing the way we think about the world around us and develop new technologies that benefit all mankind. SNAs are nanostructures that were first designed and synthesized by Mirkin as oligonucleotide-gold nanoparticle conjugates. His report of this discovery, in a 1996 paper in *Nature*, today has over 6,000 citations (Google Scholar) and remains the most-cited paper in all fields in *Nature* from 1996 onward. This extraordinary level of citation impact reflects the multitude of fields that have been influenced by Mirkin’s discovery. His report laid the cornerstones for: 1) colloidal crystal engineering with DNA, 2) the use of well-defined nanoparticle conjugates in biodiagnostic technologies, and 3) ultimately, the use of spherical nucleic acids as powerful new medicines in research as well as in human clinical trials for gene regulation and immunomodulation therapies.

Moreover, Mirkin has elevated our concept of nucleic acids, reimagining the common linear forms found in Nature to create discrete spherical architectures having no natural equivalent and that interact with living systems in completely different ways. Following on his initial discovery, Mirkin has now prepared dozens of different types of SNAs –



spherical nanostructures comprised of densely functionalized and highly oriented nucleic acids covalently attached to an inorganic or organic core, including proteins. In another form, SNAs may be core-less, hollow nanostructures composed entirely of nucleic acids cross-linked at one end only. Importantly, the properties of these chemical structures stem from a dense layer of oriented nucleic acids and are core-independent.

Mirkin also has used SNAs to present a new concept in chemistry, where the SNA core represents the 'atom', and the nucleic acids, as opposed to electrons, are the basis for programmable 'bonds' that are employed to control the formation of crystalline matter in a way not possible by using conventional chemistry. *Although many people have joined forces in the development of SNA constructs for many purposes, independently or through collaboration with Mirkin (a hallmark of his impact), all SNA work – and, more broadly, much of the work in which biomolecules are attached to nanoparticles of all kinds – can be traced back to his seminal 1996 paper.* From my perspective, these arguments strongly distinguish Mirkin from what must be a large pool of very talented nominees. I urge you to consider carefully these points and to select Chad Mirkin as this year's winner of the Albert Einstein World Award of Science.

Yours sincerely



Sir Fraser Stoddart | 2016 Nobel Laureate in Chemistry
Board of Trustees Professor of Chemistry

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JOSEPH M. DESIMONE, PH.D.
*Chancellor's Eminent Professor of Chemistry at UNC-CH
William R. Kenan, Jr. Professor of Chemical Engineering at
NC State University and of Chemistry at UNC
Adjunct Member, Memorial Sloan-Kettering Cancer Center*

December 6, 2017

Dear Members of the Albert Einstein World Award of Science Jury,

I support the nomination of Chad Mirkin for the World Award of Science in the strongest possible terms. Mirkin is eminently worthy of this award; he has made original, exceptional, diverse, and high-impact contributions to an extent that surpasses any of his peers in the area of chemistry and nanoscience and technology, or in the many other fields his work touches. A true pioneer, the body of scientific knowledge Mirkin has generated, as well as the technologies he has developed based on that knowledge (e.g., the Verigene™ system, among many others), have had immeasurable impact on humankind. I believe Mirkin's impact overall will be felt for decades to come.

Specifically of interest to those assessing candidates for the World Award of Science, Mirkin's advances related to spherical nucleic acids (SNAs) are remarkable. Mirkin introduced the first SNAs in a 1996 *Nature* article (*Nature* **1996**, 382, 607-609, a paper now cited over 6,000 times) and subsequently elucidated the properties key to their technological development in fields such as the life sciences, biotechnology, and biomedicine. Of note, Mirkin has shown that SNAs bind complementary strands 100 times tighter than the same sequence of linear DNA and naturally enter many different cell types in high quantities (while the same strands in linear form do not, an initially puzzling finding because both SNAs and cell walls are highly negatively charged and would be expected to repel one another). He identified the class of scavenger receptors responsible for this behavior and determined that SNAs have privileged access to tissues and organs and can regulate biological processes in non-toxic and non-immunogenic ways. Based on this work, Mirkin realized that *SNAs constitute a new form of DNA or RNA – a new type of nucleic acid with a different shape – with different properties from those linear, circular, and intricately folded nucleic acids seen in nature and recognized the potential for SNAs to be a fundamentally new approach for the intracellular delivery of short interfering RNAs for therapeutic purposes*. This advance is generating immense interest, and others are quickly joining in to exploit this breakthrough through the work of Mirkin's still-new company, Exicure. SNAs, I believe, may in fact be THE answer to the immensely challenging siRNA delivery problem that has escaped a viable solution by so many for decades. Thus, Mirkin's achievements involving SNAs and their uses will likely go down in history as one of the most important technological milestones of all time.

A key attribute that has fueled his achievements is Mirkin's phenomenal ability to bridge scientific disciplines to cultivate productive collaborative relationships and achieve high-impact results—his mastery of this balance facilitates his role as one of the most preeminent figures in science and technology in the modern era, not to mention one of the world's greatest inventors and innovators.

SNAs have spurred transformative advances in how we understand living systems, and especially how nanostructures interact with them, and are extending human life. As a testament to his exceptional achievements, Mirkin is one of only very few individuals to be elected into all three branches of the US National Academies (NAS, NAE, NAM). He is a Fellow of the AIMBE, ACS, MRS, NAI, RSC, and American Academy of Arts and Sciences, among others, and he has won over 120 awards, including some of the most preeminent international ones that recognize excellence in science and technology, including the Sackler Prize in Convergence Research, the Lemelson-MIT Prize, the RUSNANOPRIZE, and the Wilhelm Exner Medal. Further, from his work on PCAST to his establishment of key scientific institutes in the US and abroad (China and Singapore) to his education of over 260 scientists and engineers at the graduate and postdoctoral level and his service as an Associate Editor of *JACS* and Founding Editor of *Small*, his promotion of science, engineering, and education worldwide is without compare. With broad impacts in chemistry, materials engineering, biology, physics, medicine, and nanoscience including the technology sector, Mirkin's selection as the recipient of the Albert Einstein World Award of Science would be most fitting and absolutely well-deserved. He is eminently qualified, and I urge the jury to select him. Thank you for considering my letter.

Sincerely,

A handwritten signature in black ink, appearing to read 'J. M. DeSimone', with a long horizontal flourish extending to the right.

Joseph M. DeSimone



**MASSACHUSETTS INSTITUTE OF TECHNOLOGY
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JOHN D. MACARTHUR PROFESSOR

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December 6, 2017

Dear Selection Committee:

I write in strong support of the nomination of Professor Chad Mirkin for the Albert Einstein World Award of Science. Chad is a leading innovator in the field of nanochemistry. Indeed, his accomplishments at the intersection of materials chemistry, inorganic chemistry, and colloid and surface chemistry, especially those with applications to health-related technologies, are simply unparalleled. Relevant to this award, Chad has made many seminal contributions surrounding the synthesis and development of gold nanoparticles functionalized with biomolecules, specifically nucleic acids like DNA and RNA, that have not only opened new domains in nanoscience and technology, but have made marked impacts in society through their application in transformational life science and medical technologies.

To sum it up, Chad Mirkin can be given the lion's share of the credit for the modern exploitation of nanoparticles in biodetection, sensing, and gene regulation and immunomodulation technologies. This research began in 1996 with Chad demonstrating that DNA can control the plasmonic interactions between gold nanoparticles. This interaction is triggered by DNA hybridization and is accompanied by a red-to-blue color change. The key to this technology is that Chad realized how he could use DNA binding to surface-bound complements to control inter-particle distance. There are other interesting features surrounding this observation. Indeed, Chad also demonstrated that melting curves are much more cooperative (sharper) when the DNA is associated with nanoparticles (versus with the same sequence free in solution; an entropic effect). This feature can give higher fidelity in the recognition of specific sequences of DNA in the presence of single-base mismatches. These fundamental scientific breakthroughs, which highlight the unique chemistry of the system, led to Chad's founding of Nanosphere, which has commercialized these methods as they pertain to medical diagnostics, including the detection of proteins. Nanosphere was recently acquired by Luminex, and the technology Chad invented that underlies the Verigene System (in over half the nation's top hospitals) is the largest source of revenue for Luminex. Simple color change types of technologies like this one have great potential in health care. The chemical concepts elucidated by Chad gave rise to systems that are sufficiently easy to use and inexpensive such that they can be performed at the point-of-care, in the home, or at small clinics. It is clear that this type of technology is needed to combat the high cost of health care and the overheads associated with large hospitals. This commercial success has been key in ushering in a new era of medical diagnostics.

The bounds of Chad's innovations seem to have no limits. In recent years, he has shown that the oligonucleotide nanoparticle conjugates, which form the basis for diagnostic probes, can also be used to create a powerful new class of genetic medicines. Specifically, he has shown that a new form of DNA templated on spherical nanoparticles, which he describes as Spherical Nucleic Acids, or SNAs, are exceedingly useful as gene regulation therapies and immunotherapeutics for the

effective treatment of a number of diseases. The ability of SNAs to deliver an effective genetic payload to cells, and even topically through the skin, is simply transformational. SNAs have high efficacy relative to all other forms of DNA and RNA. By using concepts from chemistry and nanoscience to organize nucleic acids into spherical forms, Chad has shown that such structures can engage natural cellular machinery ubiquitous to all cells (scavenger receptors) to efficiently and actively enter cells and bind their targets. Hence, you get greater effects with less material. He beautifully mapped out the fundamental pathways involved in these processes and utilized that understanding to create a pipeline of drugs that are now in the clinic for GBM (a lethal brain cancer), psoriasis, and many forms of cancer (via immunotherapy and SNA stimulation of TLR9 receptors with checkpoint inhibitors) This technology is being commercialized by a company called Exicure and, by all accounts, SNAs are displaying results that will enable entirely new possibilities for personalized and precision medicine. *Their impact on human health could be at the level of innovations such as the development of orally effective antibiotics. History is in the making here, and the breadth of Chad's impact from nanoscience to surface chemistry to medicine is truly amazing.*

As I have indicated, Chad Mirkin is one of the highest impact scientists and inventors of his generation. In addition to an unparalleled publication record in chemistry and related fields, he has pushed paradigm-shifting technologies into the marketplace. Such impact is critical to the future of basic science and should be admired. Chad is one of the most cited chemists in the world. His service to the chemistry community is also outstanding as a *JACS* Associate Editor and leader on a number of US governmental committees including the President's Council of Advisors on Science and Technology (PCAST; 8 years with the Obama Administration). He has trained over 200 Ph.D. level scientists in academia and industry (over 100 of the most successful young professors working in science, engineering, and medicine today; we have one at MIT). He must be recognized as a leading visionary of our time in recognizing how chemistry and nanoscience can be applied and make a difference in the real world. In summary, Chad Mirkin's accomplishments are most deserving of the Albert Einstein World Award of Science, and I can think of no better candidate.

Best regards,

Sincerely,

A handwritten signature in black ink, appearing to read "Timothy M. Swager". The signature is fluid and cursive, with a long horizontal stroke at the end.

Timothy M. Swager
John D. MacArthur Professor of Chemistry
Director, Deshpande Center for Technological Innovation

Mirkin is most deserving of the Albert Einstein World Award of Sciences *for his discovery and development of spherical nucleic acids (SNAs), chemically well-defined nanostructures that have changed the way we think about DNA and RNA and formed the cornerstones of new fields and technologies that are impacting a multitude of scientific disciplines.* He has done more to develop the field of chemistry, particularly in the realm of nanoscience and nanotechnology, than perhaps any single researcher in the world. His discoveries have established new fields and paved the way to understanding some of the most complex issues in basic science today, including those central to understanding life itself. Moreover, his scientific contributions have led to the development of many important technologies that are changing the way we build new materials and study, understand, track, and treat disease, and therefore, significantly impacting the lives of people all over the world.

Colloidal Crystal Synthesis with DNA: Mirkin has utilized SNAs and their analogous anisotropic equivalents, to develop an entirely new field of chemistry and materials science – focused on using such structures as “programmable atom equivalents” (PAEs) for synthesizing colloidal crystals. In 1996, he developed the chemistry for modifying nanoparticles with dense layers of highly oriented oligonucleotides to create structures where the directionality of the DNA is dictated by the nanoparticle template. Since that discovery, he has explored extensively the concept and power of the DNA “bond” in programming the crystallization of all kinds of building blocks into superlattice structures with nanometer-level precision over lattice parameters and even crystal habits. *Mirkin observed that one can create “atoms” from particles with bonding properties independent of “atomic” identity.* This is an enabling observation that allowed him to create design rules for assembly (akin to, but substantially more predictive and, therefore, more powerful than Pauling’s Rules) that work for a wide range of particle compositions, as long as they are roughly the same size and shape. Remarkably, he has even shown that proteins, Nature’s monodisperse colloidal particles, can be the basis for PAEs, and, by using the same design rules that he uncovered for inorganic particle systems, he can literally engineer protein crystallization. *This work is taking the concept of materials-by-design to entirely new levels, and the number of interaction pairs and bond lengths possible with various different types of oligonucleotides provides a chemical richness that is unparalleled.* Mirkin is realizing new classes of metamaterials and catalysts and showing how DNA bonds can be used to synthesize stimuli- and environmentally-responsive architectures, including dynamic lenses and lasing materials, ushering in a new era of discovery in many fields of science spanning chemistry, biology, physics, engineering, and medicine.

Spherical Nucleic Acids in Biomedicine: Over the last two decades, Mirkin has shown that SNAs, both cored and hollow forms, have chemical and physical properties that are inherently different from linear and two-dimensional forms of DNA and RNA which make them exceedingly useful in biology and medicine. These nanostructures exhibit a synergistic combination of properties resulting from the core and nucleic acid shell, including (i) their ability to hybridize cooperatively with complementary nucleic acids and form stronger duplexes than the same sequence of linear DNA, and (ii) their ability to transfect cell membranes efficiently without the need for co-carriers and operate in both siRNA and antisense gene regulation pathways (a paradigm shift for the field). The lore prior to Mirkin’s discovery of SNAs was that nucleic acids, in the absence of positively charged co-carriers, would not enter cells efficiently. SNAs, unlike their linear counterparts, can complex scavenger proteins (Class A) that facilitate

endocytosis. Mirkin worked out the mechanism for SNA uptake and has shown that these nanostructures exhibit an ability to inhibit enzymes responsible for triggering cellular immune response and oligonucleotide degradation.

Biodiagnostics. Mirkin's discovery of SNAs has spurred researchers worldwide to study well-characterized nanostructures, whose interactions with living structures in biological environments are well-understood, and use them as novel labels for biodetection schemes both inside and outside of cells. *SNAs widely popularized the notion of toggling highly specific biomolecular interactions in "sandwich" assay-type formats, and Mirkin has developed them as probes for the highest sensitivity protein and non-PCR-based nucleic acid-based assays in the field.* As such, they are enabling some of the first commercial point-of-care medical diagnostic systems and paving the way for fundamental research in biomarker discovery as it pertains to Alzheimer's disease, cardiovascular problems, and oncology research. These SNA materials have been commercialized by Nanosphere, Inc. (a company founded by Mirkin and acquired recently by Luminex) and used in the FDA-cleared Verigene® System, which is now employed widely in top hospitals in the U.S. and around the world. *SNAs are also the basis for SmartFlares™, the only materials that can enter live cells and be used to identify and quantify genetic content at the single cell level.* These SNA materials have been commercialized by AuraSense, LLC (a Mirkin company) in partnership with Merck Millipore. More than 1,600 such structures are currently available in their catalog, and they are being extensively used in the field of cellular biology to track tumor cells, engage in high-throughput therapeutic discovery, and study cellular processes at the level of a single live cell.

Drug Design and Delivery. SNAs also constitute a powerful new single-entity gene regulation and immunomodulatory platform and are important in a wide variety of oncology treatments (e.g., glioblastoma multiforme brain cancer) and skin cancer. SNA materials constitute the only known topical agents for effecting gene regulation in skin and are the basis for human clinical trials in Europe for psoriasis. *Promising results from these human trials formed the basis for an almost \$800 million deal between Mirkin's Exicure and Purdue Pharma to bring the first SNA-based drug (so-called, AST-005) to the market.* This deal was announced in December 2016, and the research was featured in *Science* magazine (doi: 10.1126/science.aah7240) and touted as a major milestone in nucleic acid drug development. Mirkin has shown that SNAs are also immunomodulatory agents that can bolster the body's ability to destroy cancerous tumors or downregulate an overblown immune response in the case of autoimmune diseases such as lupus or rheumatoid arthritis. SNAs are 100 to 100,000 times more effective than linear nucleic acids at engaging the biological structures (toll-like receptors, TLRs) that control immunity in living systems. Mirkin has uncovered the scientific reason for this phenomenon, namely, that SNAs enter cells via endosomes, where many TLRs reside (in the walls). The oligonucleotides that comprise them are pre-aligned in an orientation that supports binding, and they are high-affinity binders. Essentially, he has shown that this form of nucleic acid is ideal for both immuno-stimulation or suppression, depending upon choice of sequence.

The story of SNAs is a unique one – perhaps one of the most far-reaching and important in modern science in terms of breadth of impact across a variety of seemingly disparate fields. Mirkin has used fundamental chemical discoveries to fuel extraordinary development spanning medicine to materials engineering. SNAs are a third important form of nucleic acids, defined and differentiated from all other forms of matter in terms of both structure and function. I urge you to recognize Chad Mirkin, the inventor and chief developer of the SNA, with the World Award of Science to highlight this achievement and spotlight the field of nanoscience in general.

CHAD A. MIRKIN, PH.D.

Northwestern University, Department of Chemistry
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Education

- 1991 NSF Postdoctoral Fellow in Chemistry, Massachusetts Institute of Technology, Cambridge, MA
1989 Ph.D. in Inorganic & Organic Chemistry, The Pennsylvania State University, State College, PA
1986 B.S. in Chemistry (Phi Beta Kappa), Dickinson College, Carlisle, PA

Professional Experience

- 2008-present Director, International Institute for Nanotechnology; George B. Rathmann Professor of Chemistry, Medicine, Materials Science & Engineering, Biomedical Engineering, Chemical & Biological Engineering, Northwestern University
2004-2008 Director, International Institute for Nanotechnology; George B. Rathmann Professor of Chemistry, Medicine, and Materials Science & Engineering, Northwestern University
2000-2004 Director, Center for Nanofabrication and Molecular Self-Assembly and George B. Rathmann Professor of Chemistry, Northwestern University
1997-2000 Charles E. and Emma H. Morrison Professor of Chemistry, Northwestern University
1995-1997 Associate Professor, Department of Chemistry, Northwestern University
1991-1995 Assistant Professor, Department of Chemistry, Northwestern University

Awards and Honors (selected, over 120 national and international total)

- 2018 2018 Ralph N. Adams Award in Bioanalytical Chemistry
2017 New York American Chemical Society Nichols Medal; Dickson Prize in Science; Wilhelm Exner Medal; ACS Fellow; Honorary Professor, Jiangnan University; Crain's Chicago Business Tech 50 2017; "10 Top 10s" Analytical Scientist Power List; Nano Today Award; Foreign Member – Chinese Academy of Sciences
2016 American Institute of Chemists Gold Medal; Thomson Reuters Highly Cited Researcher; Honorary Professor, Shanghai Institute of Applied Physics, Chinese Academy of Sciences; RUSNANOPRIZE; American Institute of Chemists Life Fellow; International Precious Metals Institute 2016 Student Advisor Award; Dan David Prize
2015 Royal Society of Chemistry (RSC) Centenary Prize; American Institute for Medical and Biological Engineering Fellow; Thomson Reuters Highly Cited Researcher; Raymond and Beverly Sackler Prize in Convergence Research
2014 Friends of the National Library of Medicine Distinguished Medical Science Award; Honorary Degree, Universidade Federal do Rio Grande do Sul; National Security Science and Engineering Fellowship (NSSEFF) Award; Thomson Reuters Highly Cited Researcher (2002-2012); ACS Nano Lectureship Award for the Americas; The Electrochemical Society's Vittorio deNora Award; Fellow of the Royal Society of Chemistry; Honorary Fellow of the Chinese Chemical Society
2013 Honorary Professor of ShanghaiTech University; National Academy of Inventors Fellow; Thomas Reuters Citation Laureate; Walston Chubb Award for Innovation; MRS Fellow; Honorary Member of the Materials Research Society of India (MRSI); Linus Pauling Award; RSC's "Chemistry World" Entrepreneur of the Year Award
2012 International Material Science Award, International Centre for Materials Science, Bangalore, India; Honorary Professor, Hunan University, China; Lee Kuan Yew Distinguished Visitor to Singapore; Honorary Degree, Nanyang Technological University, Singapore; ACS Award for Creative Invention

2011 Elected Member of the American Academy of Arts and Sciences; Van't Hoff Prize
 2010 Elected Member of the Institute of Medicine, Elected Member of the National Academy of Sciences; Herman S. Bloch Award for Scientific Excellence in Industry, University of Chicago; Einstein Professorship of the Chinese Academy of Sciences (CAS); Ohio State University Edward Mack Jr. Memorial Award
 2009 \$500,000 Lemelson-MIT Prize; Member, President's Council of Science & Technology (PCAST, Obama Administration); Elected Member of the National Academy of Engineering; Havinga Medal, Leiden University, the Netherlands; Thomson Reuters Most Cited Chemist in the World (#1); Gustavus John Esselen Award; Pittsburgh Analytical Chemistry Award
 2008 Biomedical Engineering Society's Distinguished Achievement Award; National Security Science and Engineering Fellowship (NSSEFF) Award; ACS Inorganic Nanoscience Award
 2007 iCON Innovator of the Year Award; Elected Alumni Fellow, Pennsylvania State University
 2006 Elected into Phi Beta Kappa, Dickinson College
 2005 Elected to the Board of Trustees, Dickinson College
 2004 NIH Director's Pioneer Award; Collegiate Inventors Award, National Inventors Hall of Fame; Pennsylvania State University Outstanding Science Alumni Award; Dickinson College Honorary Degree
 2003 Collegiate Inventors Award, National Inventors Hall of Fame; Raymond and Beverly Sackler Prize in the Physical Sciences, Tel Aviv University, Israel; Dickinson College Metzger-Conway Fellowship Award; ACS Nobel Laureate Signature Award for Graduate Education in Chemistry; The Forbes/Wolfe Nanotech Report, "Nanotechnology's Top 10 Power Brokers"
 2002 Feynman Prize in Nanotechnology (Experimental); Ceramographic Competition, American Ceramic Society 1st Place Entry; Esquire Magazine's "Best & Brightest in the Nation"
 2001 Leo Hendrick Baekeland Award; Crain's Chicago Business "40 Under 40 Award"
 2000 Discover 2000 Award for Technological Innovation; Elected Fellow of the American Association for the Advancement of Science; I-Street Magazine's Top 5 List for Leading Academics in Technology
 1999 Materials Research Society Young Investigator Award; ACS Award in Pure Chemistry
 1998 PLU Fresenius Award; E. Bright Wilson Prize, Harvard University
 1997 BF Goodrich Collegiate Inventors Award
 1996-01 Camille Dreyfus Teacher-Scholar Award
 1995-97 Alfred P. Sloan Foundation Award
 1995-98 DuPont Young Professor Award
 1994-97 Naval Young Investigator Award
 1993-98 NSF Young Investigator Award
 1992-94 Beckman Young Investigator Award
 1991-96 Camille and Henry Dreyfus Foundation New Faculty Award
 1989-91 National Science Foundation Postdoctoral Fellowship (MIT)
 1986-89 Lubrizol Fellowship (PSU)

National Service (selected)

- Member of the President's Council of Advisors on Science and Technology (PCAST, Obama Administration).
- Technology Advisory Group Member of the President's Council of Advisors on Science and Technology (PCAST, Bush Administration).
- Co-chaired the world study on nanotechnology research directions for societal needs resulting in: *Nanotechnology Research Directions for Societal Needs in 2020: Retrospective and Outlook*, Boston and Berlin: Springer **2010**. Roco, M. C.; Mirkin, C. A.; Hersam, M. C., editors.

- Contributed a chapter in *Nanotechnology Research Directions for Societal Needs in 2020: Retrospective and Outlook*, Roco, M. C.; Mirkin, C. A.; Hersam, M. C., editors, Boston and Berlin: Springer **2010** – Mirkin, C. A.; Nel, A.; and Thaxton, C. S. “Applications: Nanobiosystems, Medicine, and Health” pgs. 209-260.
- Contributed a chapter in *Nanotechnology Research Directions for Societal Needs in 2020: Retrospective and Outlook*, Roco, M. C.; Mirkin, C. A.; Hersam, M. C., editors, Boston and Berlin: Springer **2010** -- Mirkin, C. A.; Tuominen, M. “Synthesis, Processing, and Manufacturing of Components, Devices, and Systems,” pgs. 61-98.
- Delegate at Asia-Pacific Economic Cooperation (APEC) 2011 Summit (Honolulu, HI), with 21 world leaders, including President Barack Obama and Secretary of State Hillary Rodham Clinton, and representatives from Fortune 500 companies.
- Spoke at APEC 2011 Summit, Honolulu, HI; “Game Changing Technology Redefining the Region” (2011) with President of Chile, Sebastian Piñera Echenique.
- Chaired the PCAST report titled, “Engage to Excel” focusing on teaching and engagement issues involving students who are in their first two years of undergraduate study at R-1, 2 and 4-year institutions, and community colleges.

Professional Organizations and Boards (selected)

Gordon Research Conferences (GRC) Conference Evaluation Committee (CEC), Associate Editor of *Journal of the American Chemical Society*, Member, President’s Council of Science & Technology (PCAST, Obama Administration); American Chemical Society, Materials Research Society – Strategic Program Planning Subcommittee, American Association for the Advancement of Science, NSF Science and Technology Center for Superconductivity, Northwestern Center for Catalysis and Surface Science, Northwestern Materials Research Center, the Robert H. Lurie Cancer Center, the Nanotechnology Technical Advisory Group (nTAG), and the NSF/NIST/NIBIB Workshop: Enhancing Innovation and Competitiveness. Founding editor of *Small*, member of the Editorial Advisory Boards of *Biosensors and Bioelectronics*, *Chemical Physics Chemical Physics Letters*, *JACS*, *Angew. Chem.*, *Acc. Chem. Res.*, *Journal of Laboratory Automation*, *Nano Research*, *Advanced Materials*, *SENSORS*, *Encyclopedia of Nanoscience and Nanotechnology*, *Chemistry-A European Journal*, *Chemistry & Biology*, *Nanotechnology Law & Business*, *Journal of Materials Chemistry*, *Nanotech Briefs*, *Chemistry World* of the Royal Society of Chemistry, *Plasmonics*, *The Scientist*, *Journal of Scanning Probe Microscopy (JSPM)*, *Clinical Chemistry*, *Nano Today*, *Int. Journal of Electrochemical Science*, *Nanotechnology, Science, and Applications*, *Nano Research*, and *Nanoscience and Nanotechnology*. Science Advisory Board Member for the University of California Berkeley Lab Molecular Foundry and the International Society for Nanoscale Science, Computation, and Engineering. Homeland Security Innovation and Entrepreneurship Center (NU) 2005 – 2006. Member of the Board of Directors of Nanosphere and Aurasense. Member of the Iowa State University Oversight Board for the Ames Laboratory. Member of the External Advisory Board to evaluate the *Clinical and Translational Science Award* Program of the University of Chicago.

Companies Founded: Nanosphere, Inc. (NASDAQ: NSPH; recently acquired by Luminex); AuraSense, LLC; Exicure, Inc. (formerly AuraSense Therapeutics, LLC); TERA-print, LLC; CDJ Technologies, LLC.

Publications: over 700

Patents and Patent Applications: over 1,000 worldwide (over 300 issued)

Distinguished Lectureships and Invited Seminars: over 650

Chad A. Mirkin

10 Significant Papers

1. Mirkin, C. A.; Letsinger, R. L.; Mucic, R. C.; Storhoff, J. J. "A DNA-Based Method for Rationally Assembling Nanoparticles into Macroscopic Materials," *Nature*, **1996**, *382*, 607–609.
2. Nam, J.-M.; Thaxton, C. S.; Mirkin, C. A. "Nanoparticle-Based Bio-Bar Codes for the Ultrasensitive Detection of Proteins," *Science*, **2003**, *301*, 1884–1886
3. Rosi, N. L.; Giljohann, D. A.; Thaxton, C. S.; Lytton-Jean, A. K. R.; Han, M. S.; Mirkin, C. A. "Oligonucleotide-Modified Gold Nanoparticles for Intracellular Gene Regulation," *Science*, **2006**, *312*, 1027–1030.
4. Macfarlane, R. J.; Lee, B.; Jones, M. R.; Harris, N.; Schatz, G. C.; Mirkin, C. A. "Nanoparticle Superlattice Engineering with DNA," *Science*, **2011**, *334*, 204–208.
5. Cutler, J. I.; Auyeung, E.; Mirkin, C. A. "Spherical Nucleic Acids," *J. Am. Chem. Soc.*, **2012**, *134*, 1376–1391.
6. Zheng, D.; Giljohann, D. A.; Chen, D. L.; Massich, M. D.; Wang, X.-Q.; Iordanov, H.; Mirkin, C. A.; Paller, A. S. "Topical Delivery of siRNA-based Spherical Nucleic Acid Nanoparticle Conjugates for Gene Regulation," *Proc. Natl. Aca. Sci. USA*, **2012**, *109*, 11975–11980.
7. Jensen, S. A.; Day, E. S.; Ko, C. H.; Hurley, L. A.; Luciano, J. P.; Kouri, F. M.; Merkel, T. J.; Luthi, A. J.; Patel, P. C.; Cutler, J. I.; Daniel, W. L.; Scott, A. W.; Rotz, M. W.; Meade, T. J.; Giljohann, D. A.; Mirkin, C. A.; Stegh, A. H. "Spherical Nucleic Acid Nanoparticle Conjugates as an RNAi-Based Therapy for Glioblastoma," *Science Trans. Med.*, **2013**, *5*, 209ra152.
8. Macfarlane, R. J.; Jones, M. R.; Lee, B.; Auyeung, E.; Mirkin, C. A. "Topotactic Interconversion of Nanoparticle Superlattices," *Science*, **2013**, *341*, 1222–1225.
9. Jones, M. R.; Seeman, N. C.; Mirkin, C. A. "Programmable Materials and the Nature of the DNA Bond," *Science*, **2015**, *347*, 1260901.
10. Kim, Y.; Macfarlane, R. J.; Jones, M. R.; Mirkin, C. A. "Transmutable Nanoparticles with Reconfigurable Surface Ligands," *Science*, **2016**, *351*, 579–582.

Chad A. Mirkin

Publications (over 700 total, over 50 in *Science* and *Nature*)

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