Who is Funding Nanotechnology and How?
Evidence From Publication Analysis

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Introduction

- Nanotechnology research output in the U.S.
  - ¼ nano publications in the world (Youtie et al., 2008)
- National Nanotechnology Initiative (NNI)
  - Founded in 2001
  - Coordinating federal nanotechnology R&D
  - 25 federal agencies participating in NNI
  - 13 agencies providing R&D funding
Funding on nanotechnology

Average annual growth rate
- DOD 23%
- NSF 16%
- DOE 17%
- NIH 34%
- DOC 21%
- NASA 3%
- EPA 18%

Share
- DOD 30%
- NSF 28%
- DOC 17%
- NIH 14%
- DOC 7%
- NASA 3%
- EPA 1%
Major funding agencies

- **NSF**
  - Fundamental research across all disciplines of science and engineering

- **DOD**
  - Science and engineering research advancing defense and dual-use capabilities

- **DOE**
  - Research providing a basis for new and improved energy technologies

- **NIH**
  - Nanotechnology-based biomedical research at the intersection of life sciences and the physical sciences
NNI funding and nano publications

- Cumulative NNI funding totals to 12 billion in 2001-2010.
- Annual growth rate of federal funding is 19.7%.
- Annual growth rate of publications in USA is 21.9%.
Research questions

Who is funding nanotechnology R&D?

Who receives funding and produces research?

What is the research output?
Method: funding acknowledgement analysis

- Disclosure requirement
  - Federal grants require researchers to acknowledge the source of federal funding

- Linking research output to their funding source
  - Sources of financial support in funding acknowledgement
Data collection

- **Database**
  - Web of Science: Science Citation Index
  - Funding acknowledgement is searchable since August 2008

- **Search terms**
  - Topic: Nano*
  - Affiliation: USA
  - Publication Year: 2009
  - Language: English
  - Document type: Article

- **Result**
  - 9808 publications
# Top funding sources

82% publications contain funding sources.

65% publications are funded by 10 agencies.

<table>
<thead>
<tr>
<th>Funding Source</th>
<th># Article</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. National Science Foundation</td>
<td>3332</td>
<td>34%</td>
</tr>
<tr>
<td>U.S. Department of Defense</td>
<td>1620</td>
<td>17%</td>
</tr>
<tr>
<td>U.S. Department of Energy</td>
<td>1579</td>
<td>16%</td>
</tr>
<tr>
<td>U.S. National Institute of Health</td>
<td>1319</td>
<td>13%</td>
</tr>
<tr>
<td>China National Natural Science Foundation</td>
<td>360</td>
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</tr>
<tr>
<td>R.A. Welch Foundation</td>
<td>167</td>
<td>2%</td>
</tr>
<tr>
<td>China Ministry of Science and Technology</td>
<td>160</td>
<td>2%</td>
</tr>
<tr>
<td>U.S. NASA</td>
<td>146</td>
<td>1%</td>
</tr>
<tr>
<td>Deutsche Forschungsgemeinschaft (DFG)</td>
<td>113</td>
<td>1%</td>
</tr>
<tr>
<td>China Ministry of Education</td>
<td>100</td>
<td>1%</td>
</tr>
</tbody>
</table>
88% of federal funding in 2001-2008
61% of nano publications in 2009
Research field supported by each agency

**DOD**
- Materials Science, Multidisciplinary, 40%
- Nanoscience & Nanotechnology, 28%
- Chemistry, Multidisciplinary, 23%
- Physics, Applied, 25%
- Physics, Condensed Matter, 10%

**NSF**
- Physics, Applied, 20%
- Chemistry, Multidisciplinary, 24%
- Nanoscience & Nanotechnology, 24%
- Chemistry, Physical, 26%
- Materials Science, Multidisciplinary, 39%

**DOE**
- Chemistry, Multidisciplinary, 22%
- Chemistry, Physical, 26%
- Materials Science, Multidisciplinary, 39%
- Physics, Applied, 20%
- Physics, Condensed Matter, 14%

**NIH**
- Biochemical Research Methods, 8%
- Biochemistry & Molecular Biology, 11%
- Chemistry, Multidisciplinary, 25%
- Chemistry, Physical, 13%
- Materials Science, Multidisciplinary, 21%
- Nanoscience & Nanotechnology, 19%
Top institutions supported by each agency

**DOD**
- University of California, Berkeley: 10%
- Argonne National Lab: 9%
- Oak Ridge National Lab: 9%
- Los Alamos National Lab: 5%
- Sandia National Lab: 5%
- University of Illinois: 4%
- Pacific NW National Lab: 4%
- Lawrence Livermore National Lab: 4%
- Georgia Tech: 3%
- Northwestern University: 3%
- USN: 4%
- UC Berkeley: 3%
- University of Florida: 3%
- Rice University: 3%
- University of Washington: 3%
- Stanford University: 3%
- Georgia Tech: 3%
- MIT: 5%
- UCLA: 3%

**NSF**
- University of California, Berkeley: 10%
- Argonne National Lab: 9%
- Oak Ridge National Lab: 9%
- Los Alamos National Lab: 5%
- Sandia National Lab: 5%
- University of Illinois: 4%
- Pacific NW National Lab: 4%
- Lawrence Livermore National Lab: 4%
- Georgia Tech: 3%
- Northwestern University: 3%
- MIT: 4%

**DOE**
- University of California, Berkeley: 51%
- Argonne National Lab: 9%
- Oak Ridge National Lab: 9%
- Los Alamos National Lab: 5%
- Sandia National Lab: 5%
- Pacific NW National Lab: 4%
- Lawrence Livermore National Lab: 4%
- Rice University: 3%
- University of Florida: 3%
- University of Illinois: 3%
- UC Berkeley: 3%
- University of Michigan: 3%
- Stanford University: 3%
- UC San Diego: 3%
- Georgia Tech: 2%

**NIH**
- University of California, Berkeley: 29%
- Argonne National Lab: 9%
- Oak Ridge National Lab: 9%
- Los Alamos National Lab: 5%
- Sandia National Lab: 5%
- University of Illinois: 4%
- Pacific NW National Lab: 4%
- Lawrence Livermore National Lab: 4%
- Georgia Tech: 3%
- Northwestern University: 3%
- Michigan State University: 3%
- Harvard University: 4%
- MIT: 4%
- University of Washington: 6%
- University of Minnesota: 2%
### Funding and publication

#### Nano funding from NSF (2006-2008)

<table>
<thead>
<tr>
<th>Institutions</th>
<th>Awards (million $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 UC Los Angeles</td>
<td>9.4</td>
</tr>
<tr>
<td>2 Duke University</td>
<td>8.0</td>
</tr>
<tr>
<td>3 Caltech</td>
<td>5.4</td>
</tr>
<tr>
<td>4 Georgia Tech</td>
<td>3.9</td>
</tr>
<tr>
<td>5 Northwestern University</td>
<td>3.1</td>
</tr>
<tr>
<td>6 Indiana University</td>
<td>2.9</td>
</tr>
<tr>
<td>7 UIUC</td>
<td>2.6</td>
</tr>
<tr>
<td>8 University of Connecticut</td>
<td>2.5</td>
</tr>
<tr>
<td>9 University of Washington</td>
<td>2.4</td>
</tr>
<tr>
<td>10 North Carolina State University</td>
<td>2.4</td>
</tr>
</tbody>
</table>

#### Nano publications in 2009 funded by NSF

<table>
<thead>
<tr>
<th>Institutions</th>
<th>Publications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Northwestern University</td>
<td>157</td>
</tr>
<tr>
<td>2 MIT</td>
<td>123</td>
</tr>
<tr>
<td>3 University of Florida</td>
<td>121</td>
</tr>
<tr>
<td>4 UC Berkeley</td>
<td>98</td>
</tr>
<tr>
<td>5 UIUC</td>
<td>94</td>
</tr>
<tr>
<td>6 University Washington</td>
<td>92</td>
</tr>
<tr>
<td>7 Georgia Tech</td>
<td>84</td>
</tr>
<tr>
<td>8 Penn State Univ</td>
<td>84</td>
</tr>
<tr>
<td>9 Univ Minnesota</td>
<td>83</td>
</tr>
<tr>
<td>10 UC Los Angeles</td>
<td>79</td>
</tr>
</tbody>
</table>
Number of author affiliations

- Similar cross-institution collaboration pattern
- No difference with other publications
### Author country

<table>
<thead>
<tr>
<th>Country</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>100%</td>
</tr>
<tr>
<td>China</td>
<td>5%</td>
</tr>
<tr>
<td>Germany</td>
<td>3%</td>
</tr>
<tr>
<td>South Korea</td>
<td>2%</td>
</tr>
<tr>
<td>Japan</td>
<td>2%</td>
</tr>
<tr>
<td>England</td>
<td>2%</td>
</tr>
<tr>
<td>France</td>
<td>2%</td>
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<tr>
<td>Canada</td>
<td>1%</td>
</tr>
<tr>
<td>Spain</td>
<td>1%</td>
</tr>
<tr>
<td>Italy</td>
<td>1%</td>
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<tr>
<td>Taiwan</td>
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<tr>
<td>Russia</td>
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<tr>
<td>India</td>
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<tr>
<td>Australia</td>
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<tr>
<td>Switzerland</td>
<td>1%</td>
</tr>
<tr>
<td>Israel</td>
<td>1%</td>
</tr>
</tbody>
</table>

- **Publications funded by 4 agencies**
- **Other countries benefit from federal funding**
## Co-funding sources

<table>
<thead>
<tr>
<th>Country</th>
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<tbody>
<tr>
<td>China National Natural Science Foundation</td>
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</tr>
<tr>
<td>R.A. Welch Foundation</td>
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<tr>
<td>U.S. NASA</td>
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<tr>
<td>Deutsche Forschungsgemeinschaft DFG</td>
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<tr>
<td>China Ministry of Science and Technology</td>
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</tr>
<tr>
<td>European Commission</td>
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</tr>
<tr>
<td>Alfred P Sloan Foundation</td>
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</tr>
<tr>
<td>China Ministry of Education</td>
<td>1%</td>
</tr>
<tr>
<td>U.S. Environmental Protection Agency</td>
<td>1%</td>
</tr>
<tr>
<td>American Chemical Society</td>
<td>1%</td>
</tr>
<tr>
<td>Nature Science and Engineering Research Council of Canada</td>
<td>1%</td>
</tr>
<tr>
<td>Korean Government MOEHRD</td>
<td>1%</td>
</tr>
<tr>
<td>American Heart Association</td>
<td>1%</td>
</tr>
<tr>
<td>Petroleum Research Fund</td>
<td>1%</td>
</tr>
<tr>
<td>New York State Office of Science Technology and Academic Research</td>
<td>1%</td>
</tr>
<tr>
<td>U.S. Department of Commerce</td>
<td>1%</td>
</tr>
</tbody>
</table>

- **Publications funded by 4 agencies**
- **Top countries**
  - China
  - Germany
  - EC
  - Canada
  - South Korea
Publications funded by agencies have higher citation rates.

Small citation window
Discussion

- Federal funding is making big contribution to nanotechnology.
  - 2/3 supported by federal funding
  - 61% supported by NSF/DOD/DOE/NIH

- Research field
  - NSF/DOD/DOE: material, chemistry, physics
  - NIH: chemistry, biochemistry

- Funding recipients
  - NSF/DOD/NIH: universities; Top 10 institutions 30%
  - DOE: national labs; Top 10 institutions 50%
Discussion (cntd.)

- Internationalization
  - Author country
  - Foreign co-funder

- Research impact
  - Comparable among agencies
  - Significantly higher than other publications

- Caveat
  - Not all funded research is published.