

Comparing needs in nanotechnology research cooperation between Mexico, Argentina and Brazil

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Introduction

After fact finding missions on nanotechnology in Mexico, Argentina and Brazil in the period 2007-2008, a comparison of the state of the art of nanotechnology research and policy in these countries is possible. It appears that nanotechnology research and policy is most advanced in Brazil, which plays the role of a regional leader in MERCOSUR. Investments in research infrastructure and high quality research is also available in Mexico, but the lack of a clear government policy and early stage of networking may hamper structural international cooperation, except in basic research. In Argentina, networking and international cooperation are well developed, though mainly in single disciplinary basic science, and there is a clear government policy. The main bottleneck is the low level of investment in research infrastructure and projects.

In all three countries, funding for mobility and investment in equipment and research infrastructure is welcome. Some is offered by the national government or via bilateral cooperation with EU member states. The EU FP7 PEOPLE programme may be useful for Latin American researchers interested in cooperating with European partners, in particular Marie Curie networks for initial training of researchers, industry-academia knowledge sharing scheme and incoming international fellowships. There may also be interest in cooperation in higher education in the ERASMUS MUNDUS programme, which is funded by the EC Directorate General on Education.

The European Commission DG Research could explore interest in the DG Development in investing in research infrastructure in some Latin American countries such as Argentina, but also Chile, Colombia, Venezuela and others with basic research activities in nanotechnology, in order to contribute to the UN Millennium Development Goals. Examples of relevant activities include investments in research laboratories, equipment and human resources as well as focused projects on nanotechnology for tropical diseases, water purification, sustainable energy, agrifood, etc.

In the FP7 CAPACITIES programme, activities of international cooperation are funded. Research organisations or companies from Latin America may also participate as additional partner in the thematic programmes in FP7, including the programme on Nanotechnology, Materials and Production Processes NMP. In these thematic programmes, Specific International Cooperation Actions (SICAs) target needs of international cooperation partner countries including in Latin America. The European Commission publishes calls for

proposals in FP7 twice a year in the period 2007-2013. Bottlenecks for successful cooperation of Latin American partners include a lack of visibility of excellent Latin American research groups to potential European partners and vice versa. The NanoforumEULA project has stimulated networking to overcome this, and the ICPC NanoNet project will build upon this by developing fully searchable internet databases of research groups and individual researchers in nanotechnology in Latin America and an open access literature database. More structural bottlenecks include the shortage of high tech equipment and research infrastructure (most pressing in Argentina), and the orientation of many research groups in Latin America on basic science, which limits their opportunities for participating in applied and multidisciplinary projects in FP7.

In any case, cooperation should contribute to the national research and/or innovation policy objectives of the Latin American country, in order to contribute to its own long term societal and economic development. Furthermore, cooperation in FP7 should be in line with the EU International Cooperation Policy objectives:

- To support European competitiveness through strategic partnerships with third countries in selected fields of science and by engaging the best third country scientists to work in and with Europe.
- To enhance the production of knowledge and scientific excellence by enabling European universities, research institutions and firms to establish contact with their partners in third countries, thereby facilitating access to research environments outside Europe and promoting synergies on a global scale.
- To address specific problems that third countries face or that have a global character, on the basis of mutual interest and mutual benefit.

Comparison

	Brazil	Mexico	Argentina
Priorities in research	10 thematic networks including nanoelectronics and nanomaterials; CGEE (2008) www.cgee.org.br in Brazil shows, that all networks are very diversified and with good results in: Nanobiotechnology; Nanobiostructures; Nanophotonics; Molecular Nanotechnology; Nanobiomagnetism Nanosciences; CNT; Nanocoating; Simulation / Models; Nanoglicobiotechnology Nanocosmetics; New topics: Nanotoxicology and nano	Basic science in (inorganic and polymer) nanomaterials, bionanomaterials, energy conversion, optics, biotechnology	Basic nanoscience networks, human resource development, learning technology transfer and early stage investment in spin-offs; responsible nanotechnology development, socio-economic development of Argentina

	outreach		
National funding and strategy for nanotechnology	Ministry for Science & Technology coordinates and funds national nanotechnology networks. Regional development is leading.	Considerable funding in infrastructure and research is available, coordination and national planning lag behind	Ministry for Science and Technology coordinates and funds national and international cooperation
Activities in industry, SMEs, foreign companies R&D	Sectoral funds filled with obligatory company contributions, direct company investment in R&D is emerging (PETROBRAS, agrifood), 30-40 Brazilian and foreign companies are interested in nano, mainly spin-offs	Few contacts between academia and industry, few companies are involved (e.g. Peñoles, mining) or interested. Industrial investment is minimal	Five companies are involved in nanotechnology R&D networks. Industrial investment is minimal
Innovation, IP, education and training and other relevant policies	Transition from research to innovation policy; IP policy is in early stage, education is still mainly mono-disciplinary, with some interdisciplinary experiments incl. nano	Government policies are still being developed, education is still mainly mono-disciplinary with some interdisciplinary experiments incl. nano	Research and innovation policy is being developed since 2005, education is still mainly mono-disciplinary, many students spend part of their studies abroad
Relevant international agreements	EU-Brazilian Science and Technology Agreement	EU-Mexican Science and Technology cooperation	EU-Argentinean Science and Technology cooperation
Relevant sectors where nanotech based products can be applied	Food production, biotechnology, electricity / electronics, aerospace, textiles, metal-mechanics and Energy (incl. oil & gas); tropical diseases.	Mining, (sustainable) energy, housing, added value to natural resources (metals, minerals, agrifood)	High tech equipment, catalysis, chemistry and materials, nanomedicine, agrifood

Mexico

Mexico has a lot of natural resources including oil, gas, silver, gold, zinc and rare earths, biodiversity and human resources. There are many universities and research organisations of varying quality. A substantial number of research groups is working at a high level. Many researchers have spent part of their career in North America, Europe or Japan. The fact finding mission in Mexico (24-30 August 2007) generated a map of extensive nanotechnology research activities in North and Central Mexico and in Mexico-City. Many research groups are well-equipped and there appears to be a sufficient budget for infrastructure development. There are enough students, but technicians able to use high tech equipment like scanning probe microscopes are scarce. Most of the research is basic science and the higher education system is still mainly mono-disciplinary. Very few Mexicans have so far applied for patents

for nanotechnology inventions and most researchers lack awareness of how to apply for patents.

The mining company Peñoles is one of the few companies in Mexico interested in nanotechnology. They have set up a pilot plant for producing nanosilver particles and are looking for partners to incorporate these and other nanoparticles in textiles or other end products. Other groups are investigating applications of nanotechnology for sustainable energy and fossil fuels, and there are good opportunities for applications in water and agrifood. The North of Mexico, near the border with the USA, is highly industrialised. The six research organisations working on nanotechnology in this region are focusing on (inorganic and polymer) materials science, applied sciences and industrial services. There are first-class microscopes like SEM, HRTEM, AFM, STM, and spectroscopy and optical instruments. Nanoscience is mainly strong in synthesis of nanoparticles (Silver, gold, quicksilver, platinum and oxides), nanotubes, nanorods and nanoribbons, improving materials properties, bionanomaterials and energy conversion. In Central Mexico, research focuses on optics and biotechnology including optical (nano) materials, nanoparticles and porous materials. Optical and other microscopes for characterising nanomaterials are available. Researchers in San Luis Potosi and Queretaro excel in characterising nanomaterials including nanotubes, and measuring optical and physical properties. There is a large gap between university and industry. The south of Mexico is least developed economically. Scientific research only takes place in Merida and Puebla (optics and applied physics). Mexico City is a focal point of nanotechnology research in almost all disciplines. Several groups are cooperating with petrochemical industry. Networking of academic nanotechnology researchers in the largest university UNAM in Mexico City has existed since 2003. Other networks are emerging. Mexican researchers were also present in the Nano Mercosur conference in Buenos Aires in 2007, even though Mexico is not a member state of this South American Regional Market. There is also a Latin American network for nanotechnology and society RELANS with headquarter at the University of Zacatecas in Mexico, which includes an active group in UNAM in Mexico City.

Nanotechnology is briefly mentioned as one of the precursor technologies in a report on “Ten lines for stimulating competitiveness 2008-12” by the Secretariat for Economic Affairs. Beginning of 2008, a diagnostic and prospective study on nanotechnology in Mexico was published by the Ministry of Economic Affairs, again stressing the need for such a national plan. The European Union and the Mexican government have signed a cooperation agreement including a budget of 20 million euro for cooperative nanotechnology research projects (FONCICYT). There is still no national plan or research strategy for nanotechnology, but natural and social scientists interested in nanotechnology are lobbying for it. During the fact finding mission a representative of the Secretariat of economic affairs announced such a national plan for mid 2008, but until November 2008, no such plan has been released.

In discussions between Mexican nanoscientists and European experts during the fact finding mission, there appeared to be most interest in funding for short visits of senior researchers and in grants for PhD students for spending part of their project at a European research centre. Mexican scientists would also welcome European visitors to their laboratories. There is an EU-Mexican Science and Technology Agreement since 2005, including two main activities: the Science and Technology Cooperation Fund EU-Mexico FONCICYT and the European Union-Mexican Cooperation Programme in Science and Technology UEMEXCYT.

Argentina

An individual fact finding mission to Argentina, 19-23 November 2007 revealed that there is a national network in which nanoscientists from different disciplines and institutions are

cooperating. The government also has a national strategy for stimulating nanotechnology networking, educating human resources, and fostering start-ups, since 2005. The CNEA Atomic Energy Centre in (San Carlos de) Bariloche is a leading institute where new research infrastructure for nanotechnology is being developed. This is also the location for Instituto Balseiro, the top university education for the country's best students in Physics, Nuclear and Mechanical Engineering. There is a clear lack of investment in equipment and research infrastructure in the country and research as well as high tech companies like INVAP have suffered under the Argentinean financial crisis in 2001. Argentinean researchers cooperate with Brazilian colleagues in the CBAN Brazilian-Argentinean Centre for Nanotechnology in Brazil, and visit European and North American research groups in their own field. Senior nanotechnology researchers have made their careers in Europe or North America and are now collaborating with younger colleagues to re-establish a national science base. Most research is either fundamental science or applied research for some companies interested in applying nanotechnology in their products. The Interdisciplinary Centre for Nanoscience and Nanotechnology CINN includes research groups in the University of Buenos Aires, CNEA and CONICET research groups plus five companies in Buenos Aires, Bariloche and La Plata. Foreign companies typically don't invest in research cooperation with universities and research centres in the country. Four other nanotechnology research networks have existed since 2004 and the research centres INTA (Agricultural research) and INTI (Industrial research) are also working on nanotechnology.

There is clear interest in technology transfer and fostering spin-off companies in nanotechnology in Argentina. The Argentinean Foundation for Nanotechnology FAN manages a revolving fund for early stage investments of US\$10 million, and at the University of Buenos Aires there is interest in setting up a technology transfer unit and incubator at the faculty of exact and natural sciences. FAN is also managing a new sector fund for nanotechnology since 2008. Argentina has welcomed the European code of conduct for Nanotechnology research, published beginning of 2008 and is discussing its own code. The national ethics committee is responsible for it.

Since end of 2007, there is a Ministry for Science, Technology and Productive Innovation (MINCyT), replacing the former Secretariat for Science and Technology of the Argentinean Ministry of Economic Affairs. A Max Planck partner institute on biomedical research including nanotechnology has been established in Buenos Aires in November 2007, funded by MINCyT through CONICET. This institute collaborates with Max Planck institutes in Germany. This is one of 70 current collaborations between Argentinean and German researchers. Argentinean scientists are also cooperating with partners in other European countries. During the third steering committee meeting for the EU-Argentinean Science and Technology Cooperation Agreement, 17 April 2008, plans were made for developing a Rolling Roadmap for cooperation. The priorities are twinning European and Argentinean research groups in selected areas of common interest in Food, Agriculture, Fisheries and Biotechnologies; exploration of joint funding in other thematic areas and the appointment of FP7 National Contact Points in Argentina by the Argentinean government.

Brazil

Brazil is the strongest player in nanotechnology in Latin America. There has been a clear national strategy for nanotechnology since 2001, with a coherent investment in building up nanotechnology research networks and infrastructure connecting different regions of the country. Two of ten current networks have been developed from the start in successive funding rounds: NAMITEC (Microsystems and nanoelectronics) and RENAMI (nanomaterials). Apart from federal universities and the private university PUC Rio, national

research centres in different sectors or regions, and companies participate in these networks. The relevant national research centres include: the agribusiness research centre EMBRAPA (instrumentation, toxicology and agrifood applications), EMBRAER, the aerospace research centre, INMETRO (metrology), INPA (Amazon research) and CETENE (North East).

The federal ministry for science and technology plays a coordinating role in nanotechnology development. In the future strategy for the period 2009-2015, the emphasis will shift from building up research infrastructure and human resources to technology transfer to industry. A national IPR strategy is starting. UNICAMP owns most patents followed by PETROBRAS. For the first time projects in Nanotoxicology and communicating nanoscience by nanoscientists will be supported. Until now, the network on Nanotechnology, Society and Environment RENANOSOMA has been active in research on social aspects of nanotechnology and in public engagement with nanotechnology. This network consists of social and human scientists. There is apparently limited cooperation between the natural science and technology networks on nanotechnology and RENANOSOMA.

The total budget for nanotechnology in PACTI (2007-2010) is R\$69.99 million (~€23 million) in 4 years, from MCT/FNDCT (National Fund for Scientific and Technological Development) and MCT/other actions PPA.

Economic sectors relevant to the country which are affected by nanotechnology include:

- food production,
- biotechnology,
- electricity and electronics,
- aerospace,
- textiles,
- metal-mechanics and
- Energy (including oil and gas). (PACTI, p 144)

Industrial companies are also obliged to invest part of their profits into special national research funds for their sector. These funds are used for public academic research. On top of this, PETROBRAS is investing directly into enlarging its own research centre CENPES in Rio de Janeiro and a new building on the campus of the PUC in Rio. They also invest in research projects involving academic researchers. Nanotechnology is included in PETROBRAS work on sustainable energy, sensors and catalysis. Some agrifood sectors like the citrus fruit and sugar cane sector are also innovative and invest in relevant research to improve the quality of their products. Estimates of the numbers of companies active in nanotechnology in Brazil vary between 30 and 40. According to a Swiss survey, most of these are very small spin-offs. Brazilian local companies are mostly interested in cost reduction. Only companies exporting to Europe and the USA are interested in added value. (Györvary, CSEM). During the fact finding mission, 8 spin-offs, 12 established Brazilian companies and 5 foreign companies were referred to.

There is obvious interest in international cooperation, but it should be clear what the interests are for the Brazilian side. Learning best practices in technology transfer has a high priority. On 23 October 2008, during the steering committee meeting for the EU-Brazilian Science and Technology Agreement in Brussels, a proposal was discussed for a targeted call for proposals for cooperation projects in nanotechnology. Nanotechnology will be included in the Roadmap for this agreement, which is forthcoming.

Links:

European Union Community R&D Service including info on 7th Framework Programme:
<http://cordis.europa.eu>

EURAXESS for European research jobs and mobility: <http://ec.europa.eu/euraxess>
European Commission nanotechnology pages: <http://cordis.europa.eu/nanotechnology>
ERASMUS MUNDUS programme:
http://ec.europa.eu/education/external-relation-programmes/doc72_en.htm
European Commission DG Development: <http://ec.europa.eu/development>

NanoforumEULA project: www.nanoforumela.eu,
<http://www.mesaplustwente.nl/nanoforumela/> (Nanotechnology in Mexico, Argentina and Brazil)
ICPCNanoNet project: www.icpc-nanonet.org and www.nanoarchive.org (follow-up from NanoforumEULA project)
Nanoforum: www.nanoforum.org (NanoforumEULA publications on Nanotechnology in Mexico and Brazil & Malsch TechnoValuation publication on Nanotechnology in Argentina & other relevant information)

UEMEXCyT: <http://www.conacyt.mx/uemexcyt/>
EU-Mexican cooperation including in Science and Technology:
http://www.delmex.ec.europa.eu/en/eu_and_mexico/cooperation.htm
Mexican Secretariat of Economic Affairs, sectorial programmes
<http://www.economia.gob.mx/?P=944>
Mexico: Ten lines for stimulating competitiveness 2008-12 (in Spanish):
http://www.economia.gob.mx/pics/pages/2025_base/DiezLineamientos.pdf
Diagnostics and Foresight report on Nanotechnology in Mexico, Ministry of Economic Affairs (in Spanish): http://www.economia.gob.mx/pics/pages/944_base/Nanotecnologia.pdf

EC-Argentinean Science and Technology Cooperation Agreement:
<http://ec.europa.eu/research/iscp/index.cfm?lg=en&pg=argentina-5>
Malsch TechnoValuation report fact finding mission Nanotechnology in Argentina:
www.malsch.demon.nl, publications
Argentinean Nanotechnology Foundation: <http://www.fan.org.ar/>
Article on foundation Max Planck institute in Buenos Aires, Argentina:
http://www.mpg.de/english/illustrationsDocumentation/multimedia/mpResearch/2006/heft01/1_06MPR_77_78.pdf
Argentinean Committee on Ethics in Science and Technology: <http://www.cecte.gov.ar/>

European Delegation in Brazil, Science and Technology Cooperation:
http://www.delbra.ec.europa.eu/pt/science_and_tech/index.htm
Brazilian Ministry of Science and Technology, Nanotechnology pages (in Portuguese):
<http://www.mct.gov.br/index.php/content/view/727.html>

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