INSTITUTO DE PESQUISAS TECNOLÓGICAS

Brazilian scenario in sustainable nanotechnology

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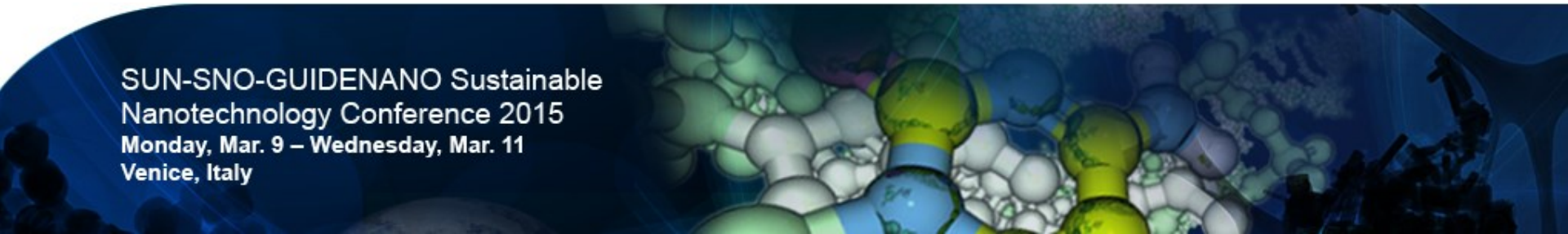


IPT – Institute for Technological Research

- One of Brazil's largest research institutes.

- Eleven technology centers acting multidisciplinarily in a broad range of fields.

BIONANO
Bionanomanufacturing Center

CTGeo
Center for Geoenvironmental Technologies

Nanotechnology in Brazil

- Since the 2000's | National program to develop and disseminate nanotechnology.

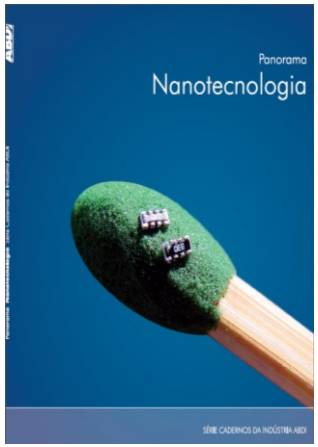
- Investments of the Brazilian government and private sector.

- 2006| Brazil was the 25th country in the world ranking of publications in this field.

- 2014| Brazil joined Nanoreg.

Nanotechnology in Brazil

- Brazilian Agency for Industrial Development (ABDI)
  - Sector reports



2010

- Evaluation of the scientific production in Brazil related to toxicity, safety and risk assessment of nanotechnologies from 1999-2008

- Search platform: Web of Science

Nanotechnology in Brazil

Table 1: Scientific production in Brazil related to toxicity, safety and risk assessment of nanotechnologies (1999-2008)

Subject	Total	Toxicity	Safety	Risk Assessment
Nanoparticles	1038	27	0	0
Nanotubes	519	3	0	0
Nanostructures	313	0	0	0
Quantum dots	429	0	0	0
Nanocrystals	291	0	0	0
Nanocomposites	303	0	0	0
Fullerenes	56	0	0	0
Nanomaterials	44	0	0	0
Nanospheres	63	6	0	0
Engineered nanomaterials	0	0	0	0

ABDI (2010)

ipt

Nanotechnology in Brazil

2011

- Lack of data in Brazil related to nanosafety.
- Necessity of encourage studies related to risk assessment (human health and environment).

2013

- Concept of life cycle impact.
- Presentation of an algorithm for classifying a product as a nanomaterial.

Goal

- General Goal| Evaluate the scientific production related to sustainable nanotechnology in Brazil.

- Main Goal| Identify LCA studies in order to evaluate the scope of the studies and methodology details.

- IPT and Sustainable Nanotechnologies

  Include the evaluation of the environmental performance (LCA) of nanoproducts developed by the Institute.

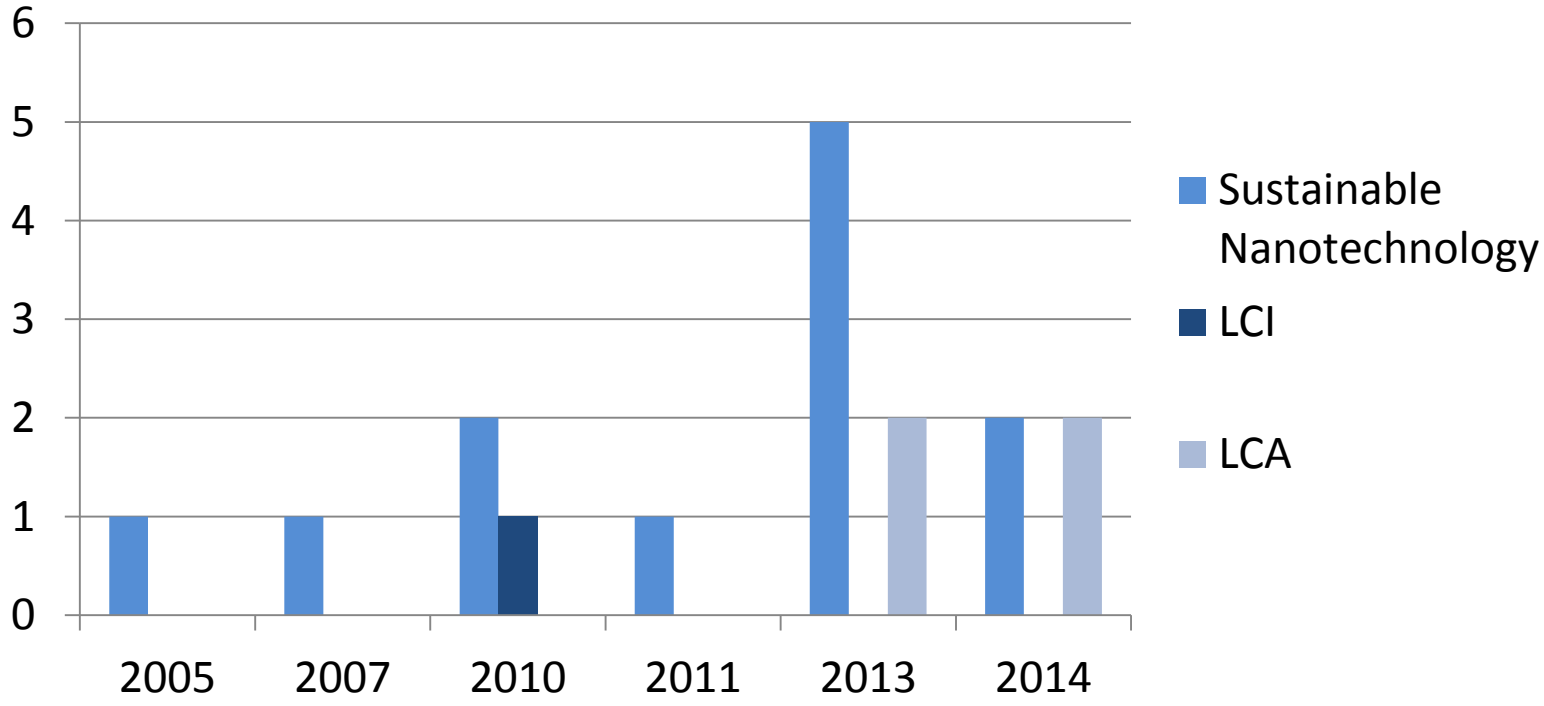
Method

- Systematic literature review
  - Period: until December 2014
  - Establishment of keywords: English and Portuguese
  - Selection of search platforms: Journals, Conference papers and thesis

- The works were classified into sustainable nanotechnology and life cycle assessment.
  - Sustainable nanotechnology: presents a discussion regarding the effect of the nanomaterials in the environment.
  - Life cycle assessment: LCI and LCA studies

Results

- Literature highlights that after 2010 the discussion regarding the environmental impacts of the nanotechnology has increased.



Results

Sustainable Nanotechnology

- Goal/Discussion of the authors
  - Potential environmental impact of nanomaterials.
- Characteristic of the nanoparticles can facilitate its dispersion into the environment.
  - Particle size is just one of the factors defining the effects.
- Routes of exposure, access and distribution of nanomaterials in the environment.
  - Greater concern with the inhalation of nanoparticles.

Results

Sustainable Nanotechnology

- Importance of characterize, quantify and evaluate the toxicity of the nanomaterials.
- Necessity of standardized toxicological tests for nanomaterials.
- Toxicological and biodegradation data on nanoparticles are scarce, although there are commercial products on the market.

Results

Life Cycle Inventory

2010. CAVALCANTE et al.

- Nanomaterial| Cellulose nanocrystals from coconut fibers
- Functional unit| 1g of nanocrystals from coconut fiber
- Boundaries| Milling, washing, bleaching and sulfuric acid hydrolysis
- Environmental aspects quantified
  - Water
  - Energy
  - Emissions to water (BOD, COD)

Results

Life Cycle Assessment

- Nanomaterials| cellulose nanowhiskers obtained from tropical vegetal fibers
  - Cotton (2)
  - Coconut (2)
  - Sugarcane bagasse (2).
- Functional unit| g of cellulose nanowhisker.
- Boundaries
  - From agriculture production to extraction of the nanowhiskers.

Results

Life Cycle Assessment

- Data quality
  - Primary data: agriculture production in Brazil and extraction of nanowhiskers.
  - Ecoinvent database.

- Method| ReCiPe Midpoint H

- Impact categories
  - Eutrophication (2)
  - Human toxicity (3)
  - Ecotoxicity (2)
  - Climate change (2)
  - Acidification (1)

Conclusions

- The environmental aspect was usually discussed in the field of risk assessment, but few studies aimed to quantify the impacts.

- LCA studies performed by EMBRAPA
  - Cradle to gate and focused in the inventory of the production of the nanomaterial in Brazil.

  - Cellulose nanowhiskers have great potential to reinforce the mechanical properties of different polymers and their production is expected to grow in near future.

Conclusions

- LCA as a methodology to evaluate the impact and to help decision making
  - Selection of materials
  - Comparison of process
- Little emphasis has been given to the use and end of life phases.
- LCA can help identify opportunities for reducing environmental impacts in the entire life cycle of nanoproducts.

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