Nanotechnology and ALM: challenges and opportunities

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- Interfaces can be huge and dynamical
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Introduction to UNAM

Universidad Nacional Autónoma de México, 1551

342, 542 students
28, 018 graduates
38, 793 lecturers
30% of mexican peer-reviewed publications
Campus in all over the country and Canada, USA, Great Britain, Spain, China, Costa Rica and France

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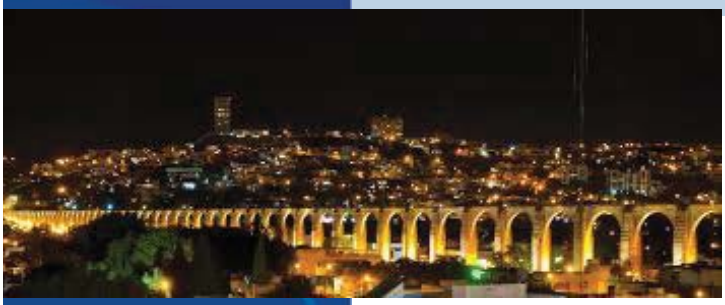
Querétaro, 1531

UNESCO World Heritage City



Centro de Física Aplicada y Tecnología Avanzada, 2002

- Department of Nanotechnology
- Department of Molecular Engineering of Materials

Projects related to ALM

- Nanomaterials
- Biomedical Engineering

Academia de Ingeniería MÉXICO

- Biomaterials
- Biomimetic materials
- Functional materials
- Recyclable materials

Materials and ALM

ALM requieres suitable materials

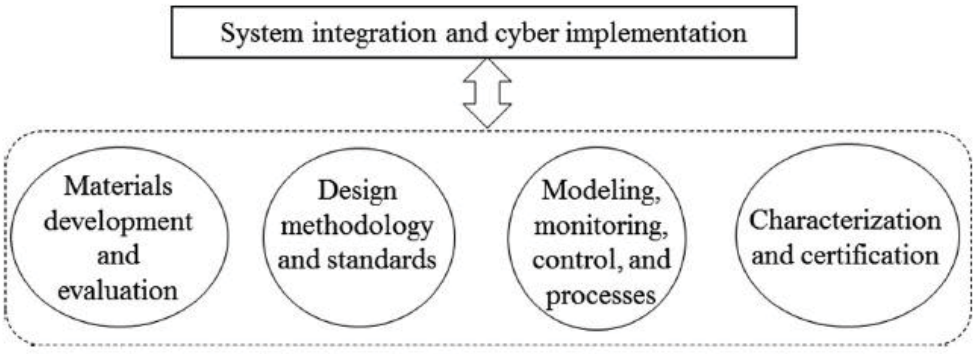


Fig. 1 Four essential technology elements and system integration for viable AM

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ROYAL ACADEMY OF ENGINEERING

Additive manufacturing: opportunities and constraints

A summary of a roundtable forum held on 23 May 2013
hosted by the Royal Academy of Engineering

The road ahead – challenges and opportunities for AM

Despite its clear benefits, AM remains beset by technological issues and suffers from the lack of a supportive framework, underfunding and a lack of industry standards. During the meeting, attendees carefully enumerated the problems and suggested possible solutions.

Materials

There is a demand for better materials to use as feedstock for AM and 3D printing. The development of machines that can process metals by sintering (creating objects from powders) is helping to open up the processes to industrial users. However, while new metal alloys such as Scalmalloy[5] address manufacturers' needs, polymers require greater research and development. Professor Bill O'Neill, Cambridge University Professor of Laser Engineering, described existing UV resins for stereolithography as "toxic – you wouldn't want to lick them." Dr Chris Tuck, Associate Professor of Additive Manufacturing and 3D Printing Research Group at the University of Nottingham, called materials "the real issue and the biggest opportunity in AM".

In addition, while metals used in AM processes are often recyclable, polymers quite often are not – and the feedstock comes with significant embedded energy from the processes used to create it. As well as focusing on the functional aspects of materials, a

INSS
INSTITUTE FOR NATIONAL STRATEGIC STUDIES

September 2012

DEFENSE HORIZONS

National Defense University

Toward the Printed World: Additive Manufacturing and Implications for National Security

by Connor M. McNulty, Neyla Arnas, and Thomas A. Campbell

AM Research Opportunities

Printed electronics and hybrid AM systems	Need to develop "printable" conductive materials and inks that can be integrated into existing AM processes. Need for development of hybrid AM systems that incorporate multi-material deposition capability to enable the creation of parts with embedded electronics.
Bio 3D printing	Need to develop bio-compatible materials and AM processes capable of being certified for medical device fabrication

BL High Performance Polymers - Development of Materials for AM

EVONIK INDUSTRIES

Mechanical properties

Surface quality

Processability

BL High Performance Polymers Biobased SLS material

EVONIK INDUSTRIES

Pilot plant for omega-amino lauric acid (ALS) since beginning of 2013

Alternative to petroleum based laurin lactam

Material 100 % bio based

Applicable to SLS

Interfaces can be huge and dynamical

Dry Condition

Failed by **Concrete Delamination**

Wet Condition

Failed by **Interface Separation**

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Layered materials = interfaces

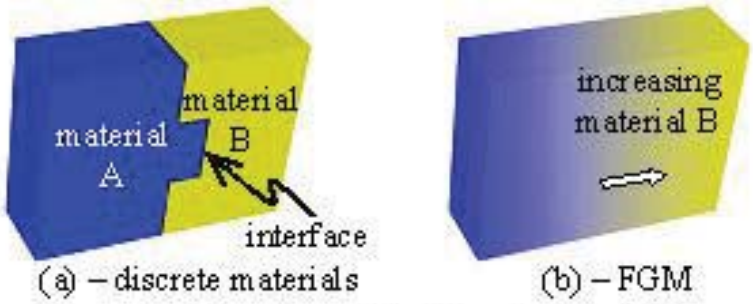
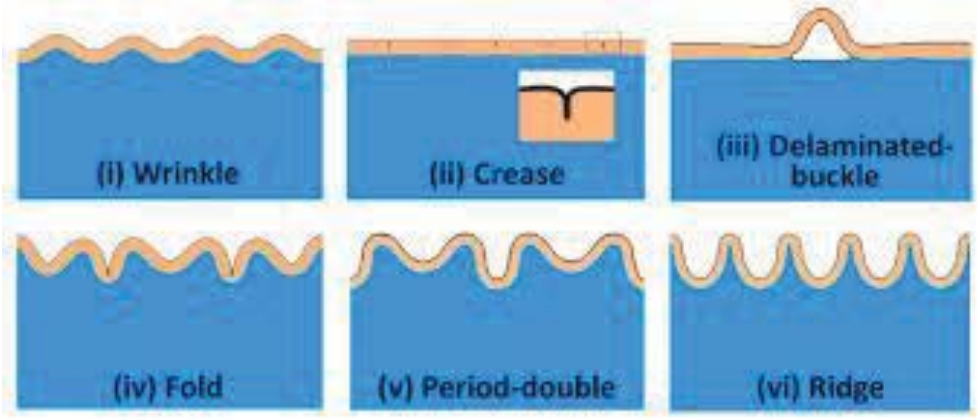


Figure 1 – Two types of multi-material objects



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How big and dynamical an interface is?

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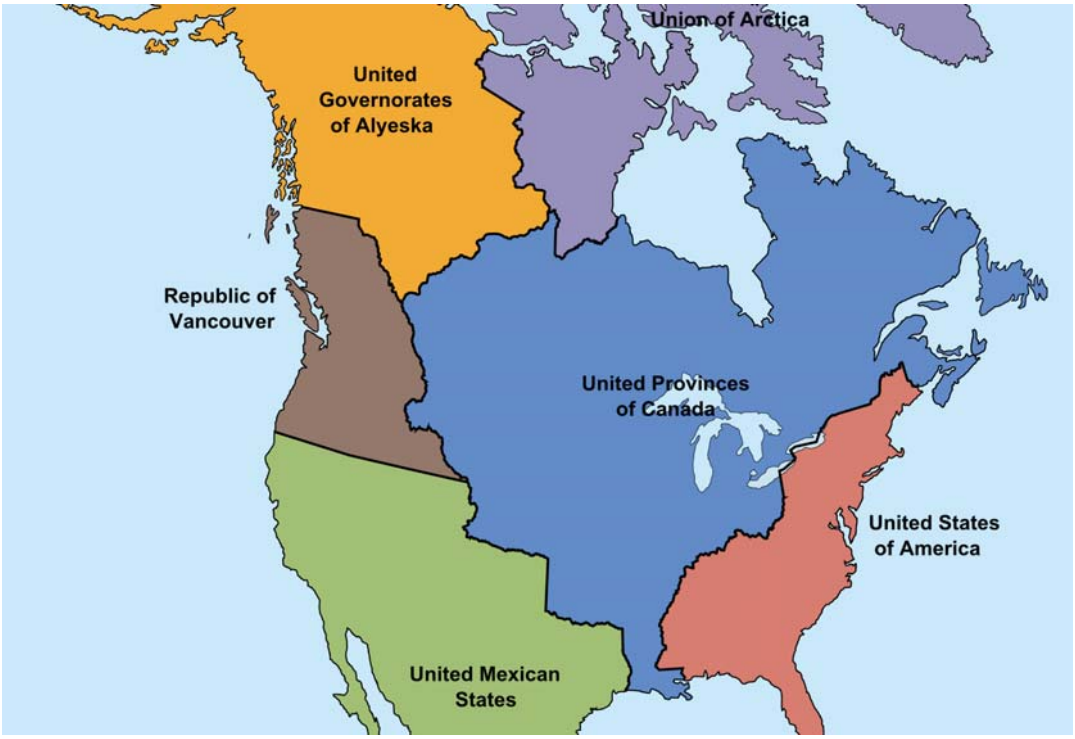
North America
GREENLAND
Baffin Bay
Bering Sea
Gulf of Alaska
Labrador Sea
Hudson Bay
CANADA
Atlantic Ocean
Pacific Ocean
UNITED STATES
BERMUDA
CARIBBEAN
MEXICO
Gulf of Mexico
Caribbean Sea
CENTRAL AMERICA



Nanotechnology and interfaces

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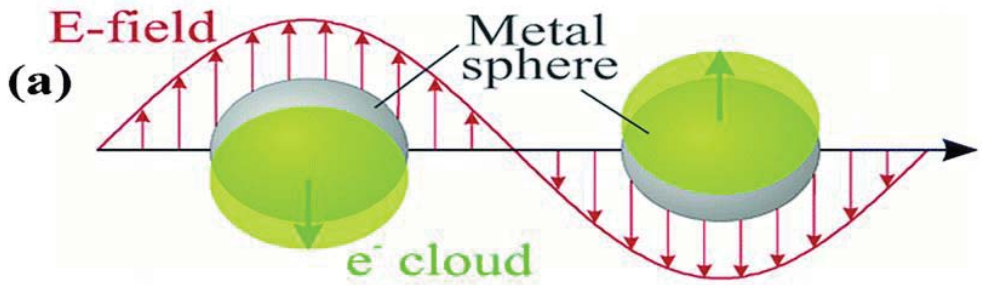
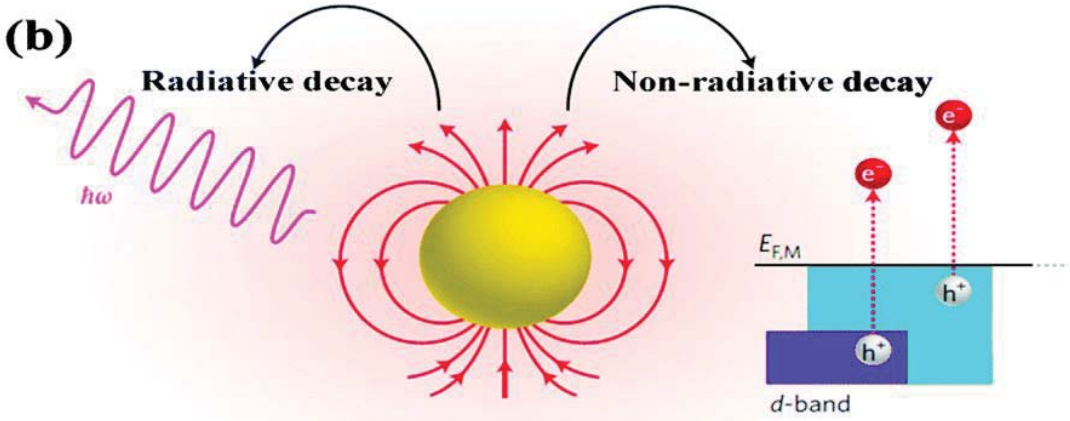
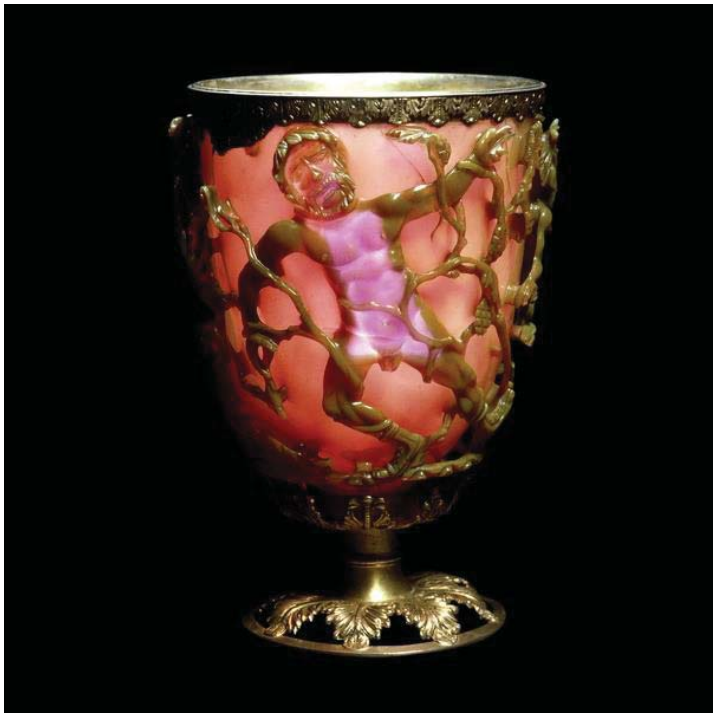
- Control of surface area/mass
- Material: Au
  - 1 x 1 x 1 cm cube
  - V = 1 cm^3
  - Mass = 19.3 g
  - Surface area = **6 cm^2**
- 10x10x10 nm nanocubes
  - No. of nanocubes = 1 x 10^{18}
  - V = 1000 nm^3
  - Surface area per nanocube = 600 nm^2
  - Total surface area= 6 x 10^{20} nm^2

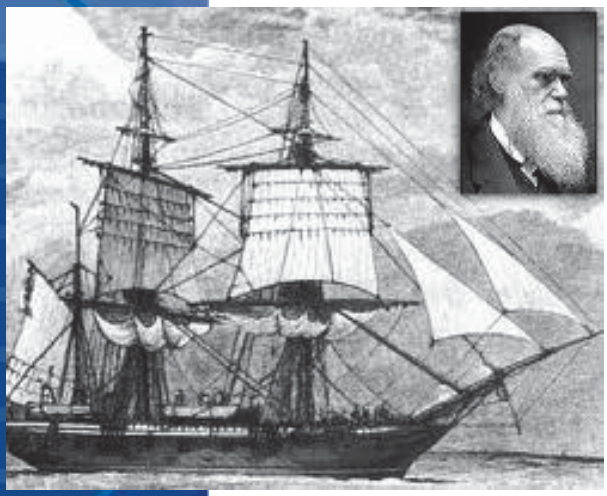
= **6 000 000 cm^2**

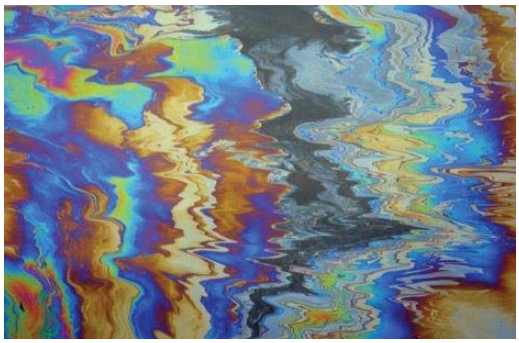


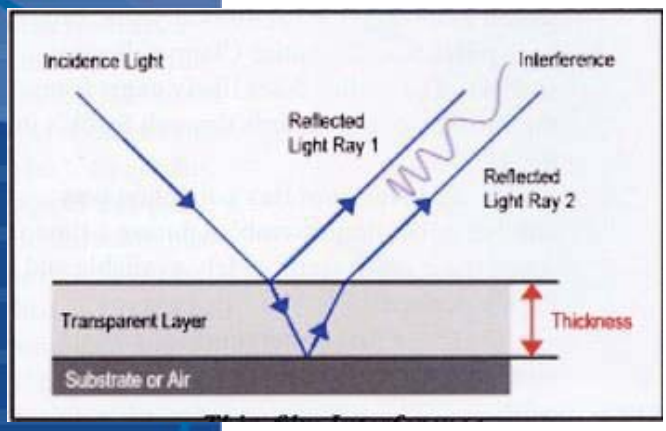


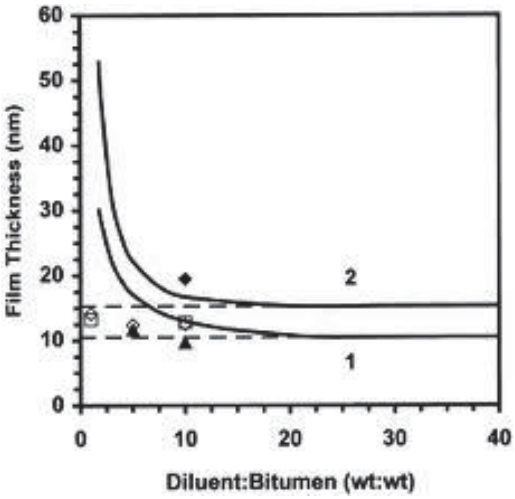
Lycurgus cup, British Museum











WHAT CAN WE LEARN FROM MOTHER NATURE?

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Advanced natural materials