

Tribology needs for the 2000's



August 2010

Dr. Luis San Andres

Tribology?
What is it for?
Will I ever use it?

Tribology needs for the 2000's



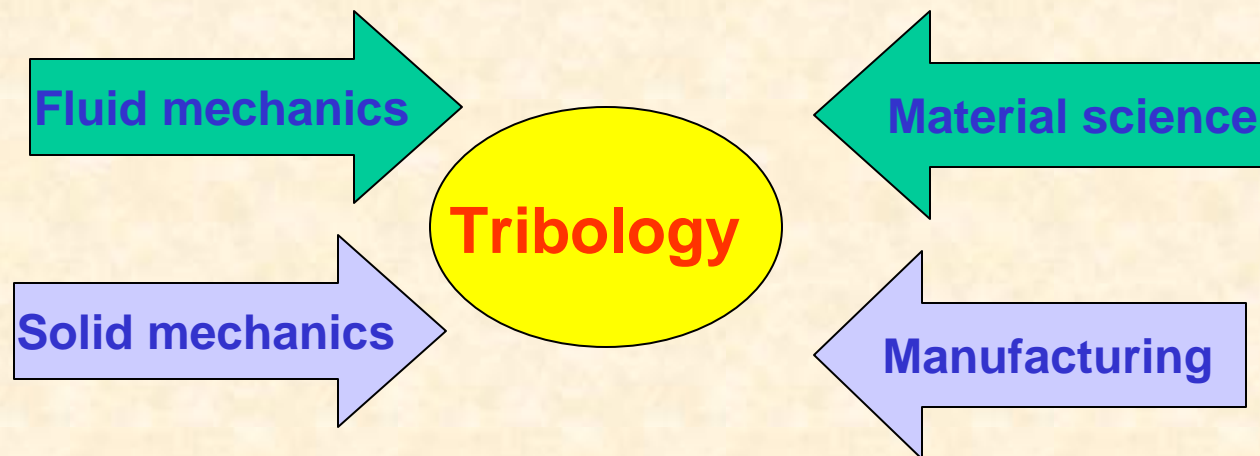
August 2010

Dr. Luis San Andres

Tribology embodies the study of
friction, lubrication and wear.

and involves mechanical processes (motion and deformation).

A **tribologist** performs engineering work to predict and improve the performance (**how much**) and reliability (**for how long**) of a mechanical system.



Tribology needs for the 2000's



August 2010

Dr. Luis San Andres

Applications:

Ultra-performance (reinjection) compressors: > 10,000 psi (700 bar)



*Rotordynamics,
materials,
hydrodynamics*

Dual gas turbines (fuel and coal):
secondary combustion on turbine side



*composite materials,
coatings,
extreme environments*

Smart engines and structures:

control of surge and stall in compressors, elimination of vibration and noise through changes in configuration,



*electronics
coatings: nanopowders
elasto-hydrodynamics*

Unmanned Aerial Vehicles:

war at a distance, no casualties
surveillance



*surface engineering,
materials,
controls and
electronics.*

Tribology needs for the 2000's



August 2010

Dr. Luis San Andres

Applications:

Meso-micro turbomachinery:

dime size fuel cells (4 kW), 1 million rpm



*Rotordynamics,
litho processes,
materials*

Reusable rocket engines:

LH₂ and LO_x fluid film bearings and seals



*hydrodynamic
lubrication (turbulent
flow)*

Oil-free gas turbines and generators:

(mid size to 0.5 MW): **foil gas bearings,
damper seals.**



*coatings: nanopowders
gas lubrication &
materials*

Information storage > 100 Gbytes/in²:

lubricated bearings and textured surfaces
with operation films or gaps less than 0.1 μm



*surface engineering,
hydrodynamics*

Tribology needs for the 2000's



August 2010

Dr. Luis San Andres

Other applications:

Sports equipment:

compliant, durable, tough, better performance
(less friction and less wear)



*Surface engineering,
materials.*

Medicine:

Hip-joint replacements,
miniature pumps for fluid injection/removal,
heart pumps and implants,
1 MRPM dental hand drills



*Surface engineering,
materials,
lubricants.*

Ultra-hard drilling equipment:

no wear and tear, i.e. infinite life



Gas hydrodynamics



*Nanopowder
coatings,
Surface engineering*

Turbomachinery needs:



Dr. Luis San Andres

**Largest power to weight ratio,
Compact & low # of parts**

**Reliability and efficiency,
Low maintenance**

**Extreme temperature and
pressure**

**Environmentally safe (low
emissions)**

Lower lifecycle cost (\$ kW)



High speed

*Rotordynamics &
(Oil-free) Bearings & Sealing*

Materials

*Coatings: surface conditioning for
low friction and wear
Ceramic rotors and components*

Manufacturing

*Automated agile processes
Cost & number*

Processes & Cycles

*Low-NOx combustors for liquid &
gas fuels
TH scaling (low Reynolds #)*

Fuels

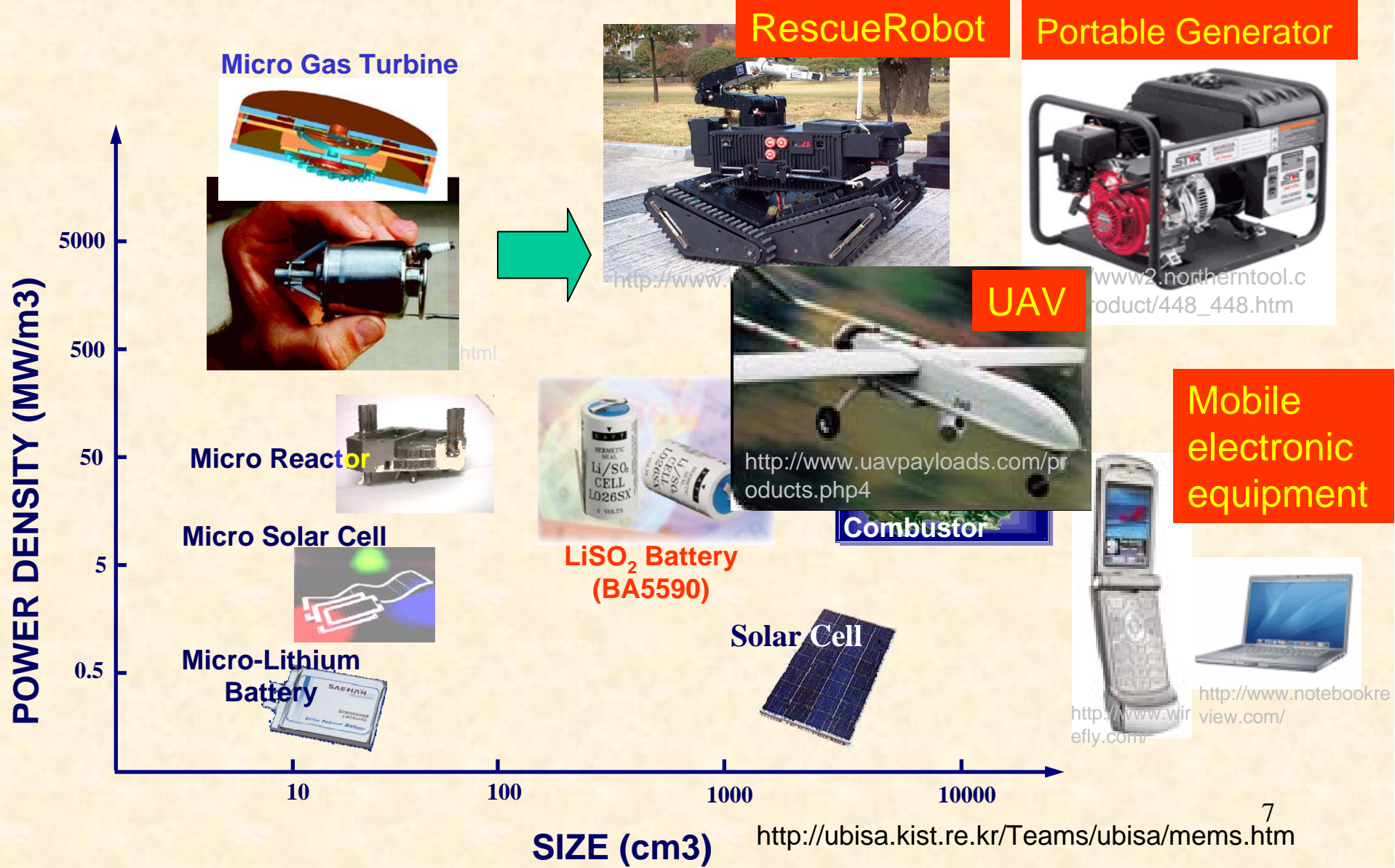
Best if free (bio-fuels)

Application of Meso/MEMS MTM



August 2010

Dr. Luis San Andres



Tribology needs for the 2000's



August 2010

Dr. Luis San Andres

Read [ppp](#): Microturbomachinery Applications 2009

for more details

Useful websites

NASA Oil-Free Turbomachinery Program <http://www.grc.nasa.gov/WWW/Oilfree/>

DOE <http://www.eere.energy.gov/de/microturbines/>

Capstone micro turbine <http://www.capstoneturbine.com/>

Mohawk Innovative Technology, Inc. <http://www.miti.cc/>

MIT Gas Turbine Lab. <http://web.mit.edu/aeroastro/www/labs/GTL/>