Texturing at the Nano/Micro-scale over Large Areas

- Extramural Session on Energy Manufacturing -

2011 NSF Engineering Research and Innovation Conference
Division of Civil, Mechanical and Manufacturing Innovation (CMMI)
Tuesday, January 4, 2011, 8:00 – 9:45 a.m.

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AGENDA

8:05 – 8:10 Introduction – K. Ehmann, Northwestern University

8:10 – 9:10 Invited presentations

Large-scale physical and chemical texturing of surfaces for engineering and biomedical applications - Yip-Wah Chung, Northwestern University

Laser Surface Texturing/Crystallization for thin film solar cell technology - Y. Lawrence Yao, Columbia University

Challenges in fabricating large-area metallic materials for energy economy - Paul H. Steen, Cornell University

9:10 – 9:45 Discussion

Why are surfaces important and what has prevented us from doing the obvious?

- Both pragmatic and experimental evidence clearly support the fact that surface properties are among the dominant factors that define functional performance.
- The surfaces of engineered components are too often "taken for granted" and accepted "as-is" as a consequence of the processes used in their generation.
- The efforts and costs of deliberate surface finishing vs. benefits, are unclear as is the answer to the largely unexplored question *"What are the achievable maximal benefits from a sophisticated engineered surface?"*
- The crux of the problem is, however, the lack of theory and understanding on how to design and manufacture surface features with desired behaviors and how these features will impact friction, wear, durability, etc. under a given set of operating conditions.

The Insufficiently Explored World of *"ENGINEERED SURFACES"*

The confluence of technology advances in:

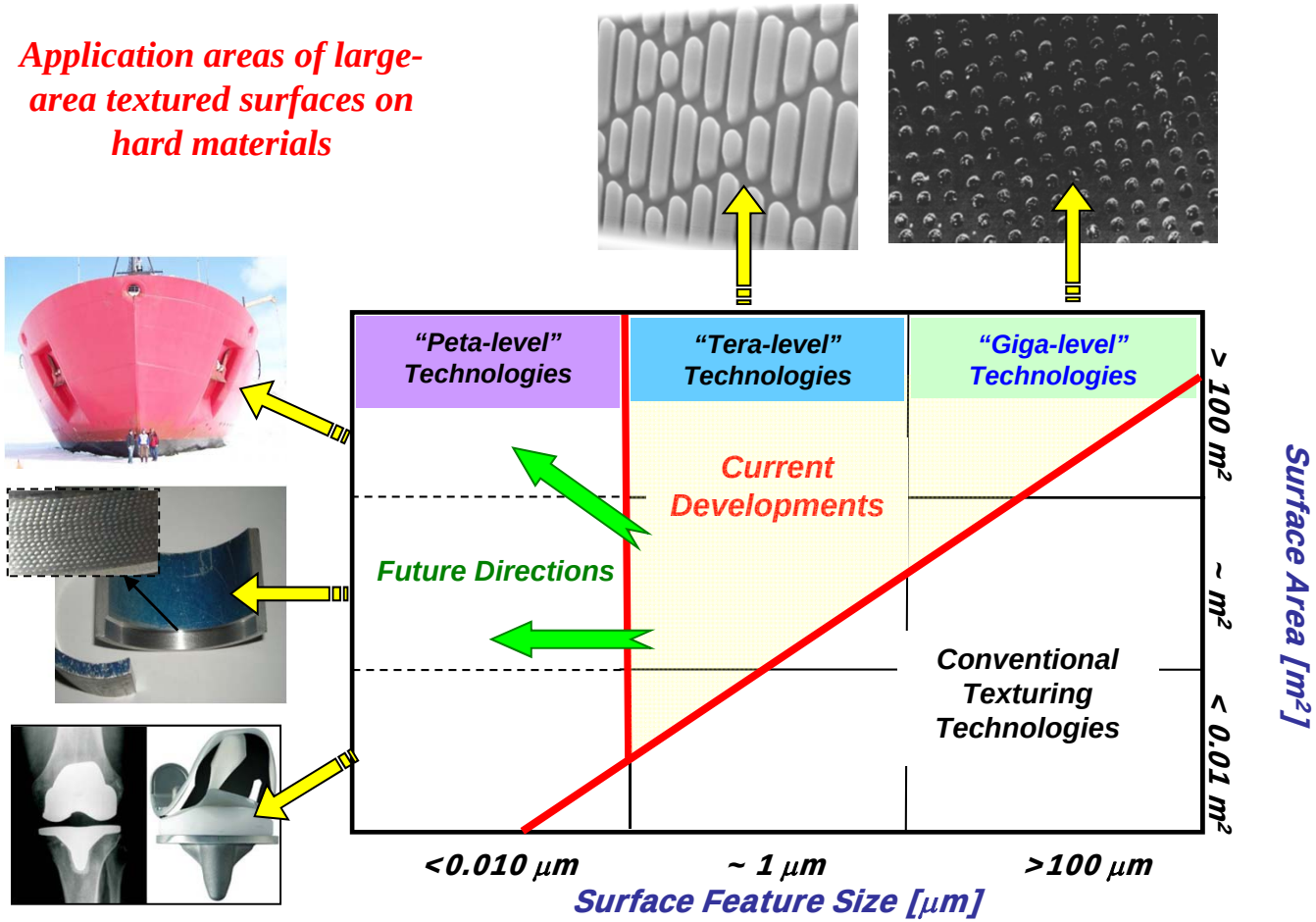
Surface texturing
Quasi-crystalline, diamond-like carbon, etc. films
Functionally graded coatings
Nanomaterials (nanostructured films, particles, fluids)
Radically new lubricant chemistries
Etc.

offers endless opportunities for an optimized combination of surface textures, thin films, and new chemistries to create new "ENGINEERED SURFACE" technologies that have the potential to:

Control friction for energy efficiency
Significantly change functional behavior
Increase system durability
Etc.

Definition of Surface Texturing Domains

Application areas of large-area textured surfaces on hard materials



"X-level" designates (# of surface features/m²)

Research and Development Goals

GOAL: Establishment of the fundamental science and manufacturing technologies in nano/micro-scale processes and systems for the creation/generation of uniquely textured surfaces on a wide range of hard materials and over large areas with prescribed functional properties.

***ISSUES*:** effects of scaling, influence of microstructure on surface modification, physics of process/surface interactions, how thermo-mechanical properties govern material removal and deformation, process capabilities/productivity, etc. (a very long list)

NOTE: *The above problems are generic and broadly epitomize the entire spectrum of challenges that are encumbering progress in many current nano/micro-manufacturing technologies.*

THANK YOU!

QUESTIONS?