

3rd Tri-National Workshop on Standards for Nanotechnology

Documentary Standards Activity for Scanned Probe Microscopy:

ISO TC201/SC9 and SG3: *Guidelines for Image/Artifact Interpretation*

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Outline

- Introduction
- ISO/TC201/SC9:
 - Scope & Timeline
 - SGs, WGs, and ongoing work items
- Ongoing work items and proposals:
 - SG2/3 - AFM tip characterizer – ‘comb’ sample
 - SG6 - ESPM resolution standard
 - SG4/WG1 - NSOM resolution standard
 - SG3 – scan parameter optimization, contrast mech.
- Preview of SG3 Chair’s Perceived Needs from Tri-National Cooperation Perspective
- Summary and Discussion



Sub-Committees of ISO/TC201

ISO/TC201 – Surface Chemical Analysis

Current TC201 Sub-committees:

- *SC1 – Terms and Definitions*
- *SC2 – General Procedures*
- *SC3 – Data Management**
- *SC4 – Depth Profiling*
- *SC5 – Auger electron spectroscopy*
- *SC6 – SIMS*
- *SC7 – XPS*
- *SC8 – Glow Discharge Spectroscopy*
- *SC9 – Scanned Probe Microscopy*

*Technology cross-cutting sub committee



Timeline of SC9 Activities

- **October 2003** – Sub-committee SC9 on scanned probe microscopy chartered by TC201
- **October 2004** – First meeting of SC9
 - Five Study Groups chartered
 - U.S. designated to lead SG3
 - *R. Dixon nominated SG3 chair*
- **Sept. 2005** – Chairs of SGs present first year findings at meeting of TC/201/SC9
- **Nov. 2006** – Chairs of SGs present second year findings at TC/201/SC9 meeting
 - *WG1 launched from SG4*
- **Nov. 2007** – Chairs of SGs present third year findings at meeting of TC/201/SC9
- **Sept. 2008** – Chairs of SGs present fourth year findings to SC9 –
SG6 on electrical SPM is launched



Scope of SC9: SGs and Work Items

TC201/SC9 sub structure:

Initial Study Groups:

- *SG1 – Business Plan*
- *SG2 – SPM Calibration*
- *SG3 – Artifacts in AFM Imaging*
- *SG4 – NSOM*
- *SG5 – SPM Probe/Tip effects*
- *SG6 – Electrical SPM*

Working Groups and Work Items:

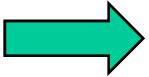
- *WG1 – NSOM*
 - AWI: Definition/calibration of spatial resolution
- KATS, J. Kim
- *SC3/WG1 – Data Transfer*

NWIP: Standard Format for SPM Data Sharing



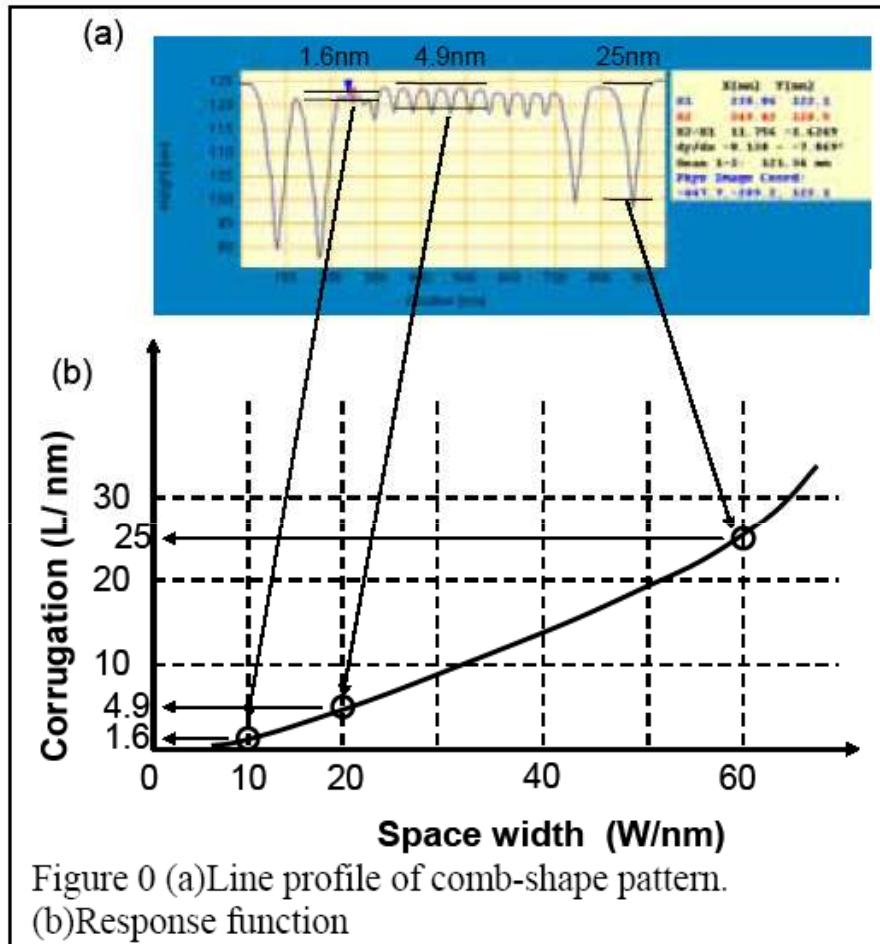
Scope of SC9: New Work Item Proposals

TC201/SC9 Current New Work Item Proposals (NWIP):

- *SG2 – SPM calibration*
 - *SPM drift rate definition and appropriate calibration methods for its determination (Prof. Huang)*
 - *SPM calibration guideline (Dr. Dziomba)*
 - *Reference Materials and Calibration Methods for SPM (Dr. Itoh)*
 - *Standards on the measurement of angle between an AFM tip and surface and its certified reference material (Dr. Seongmin Cho)*
 - *SG5 – SPM Probe/Tip effects*
 - *Procedure for in situ characterization for AFM probes used for nanostructure measurement (Dr. Ichimura & Dr. Itoh) SG5*
-  ***Round robin sample evaluation is underway.***
- *Atomic force Microscopy- Determination of cantilever normal spring constant (Dr. Clifford) SG5*

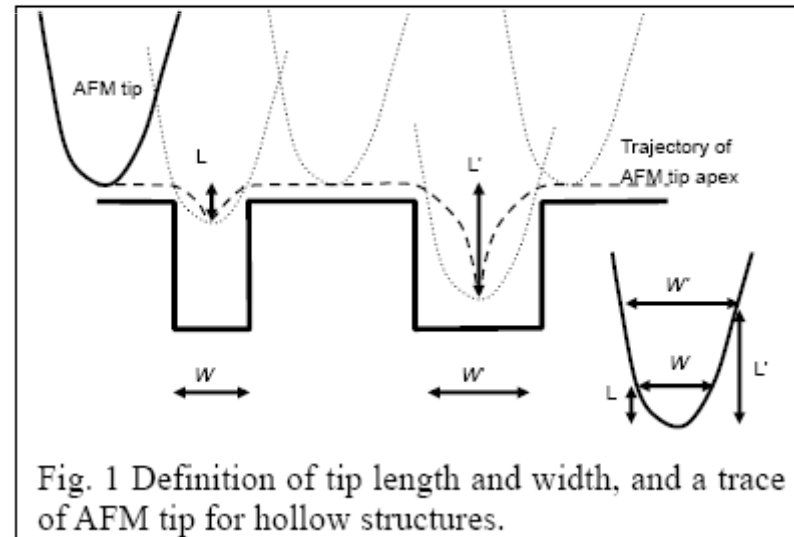


NWIP: AFM Tip Characterization



Basic Idea:

Use apparent depth of variable width trenches to characterize tip shape. (SG3 Chair sees empirical nature of method as advantageous.)



NWIP: Tip Characterization

This method does require a suitable 'comb' sample.

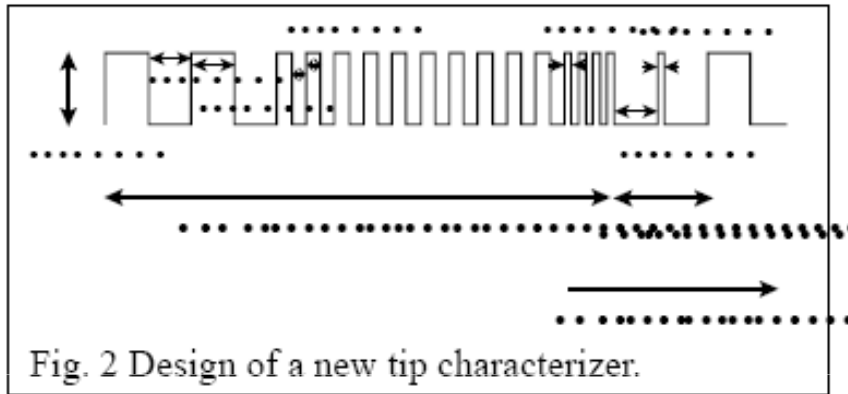


Fig. 2 Design of a new tip characterizer.

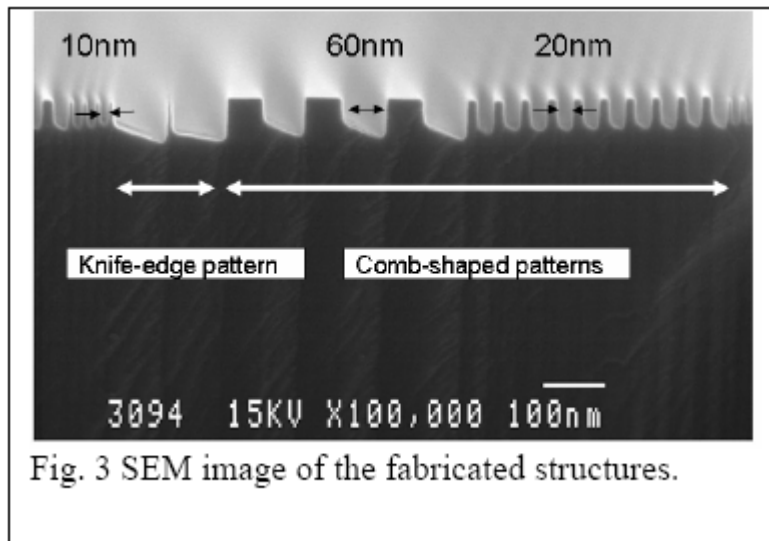


Fig. 3 SEM image of the fabricated structures.

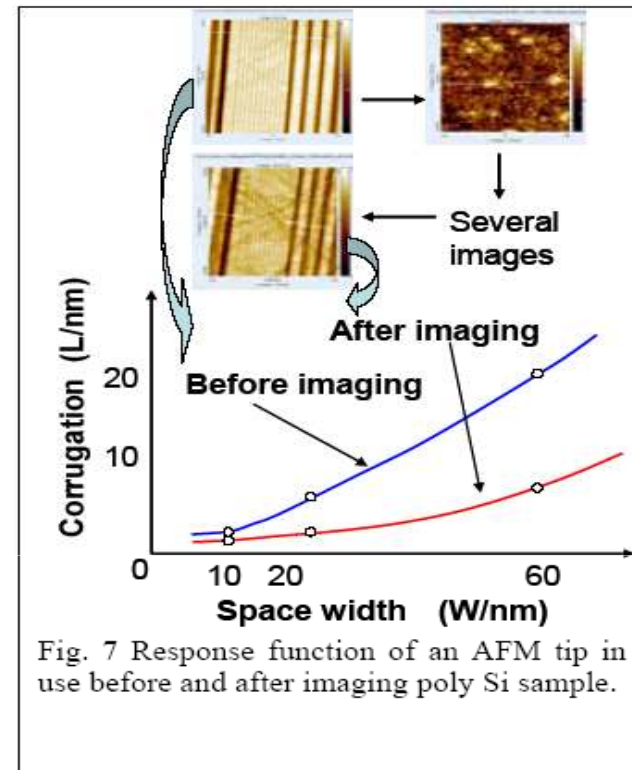
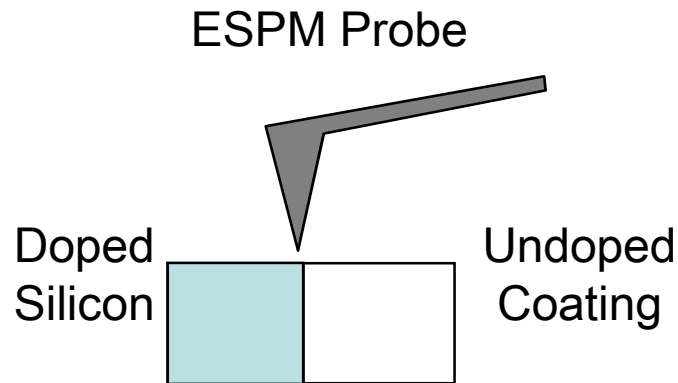


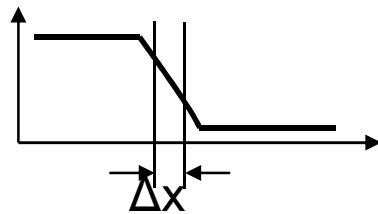
Fig. 7 Response function of an AFM tip in use before and after imaging poly Si sample.

SG3 Chair believes method may have appeal within semiconductor industry –particularly etch depth metrology on automated systems.

SG6 New Work Item: Resolution Standards for Electrical SPM Methods (e.g. SCM, SSRM)



Proposer:
Dr. Dal Hyun Kim,
KRISS

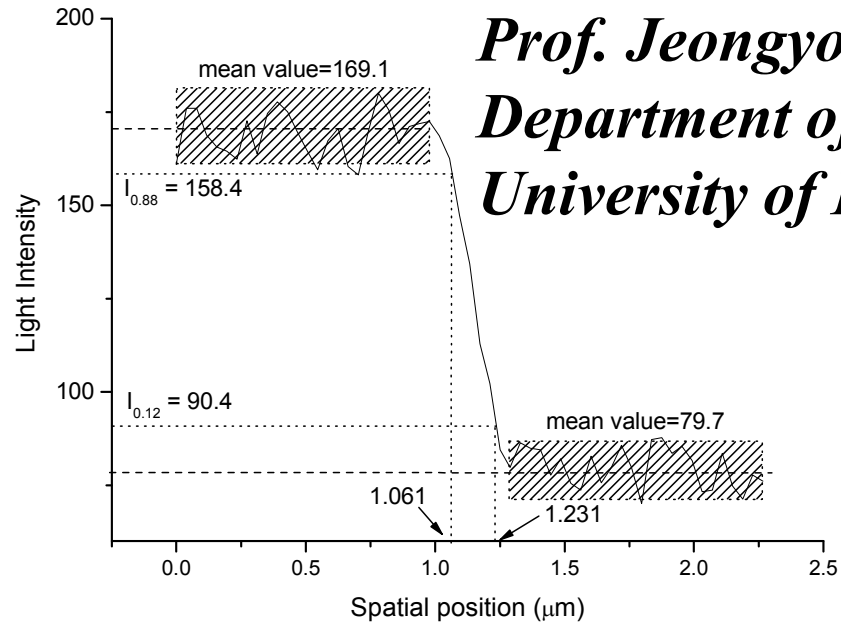
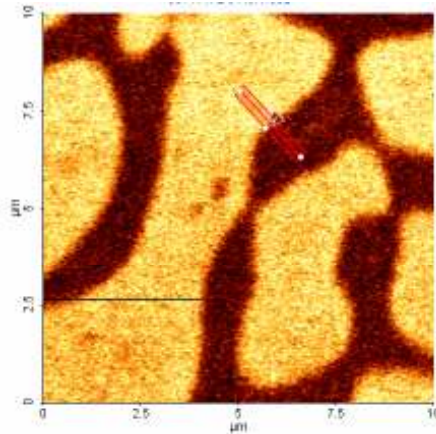


Undoped silicon grown on doped substrate could have a sharp transition in resistivity that could be useful as a probe resolution standard.

Fig. 1 Sharp edge method applied to ESPM

WG1 (was SG4) New Work Item: Resolution Standards for NSOM

Proposer:
Prof. Jeongyong KIM
Department of Physics
University of Incheon



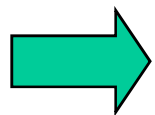
Fluorescent imaging of polymer blend film for NSOM resolution standard. Different optical properties of the separated phases provide a sharp edge.

Ongoing Activities in SG3

As a result of the year two survey and year three poll of SG3 experts, the SG3 chair proposed the initiation of two new work items during year four of SG3:

(1) Overview of scan parameter artifacts in AFM imaging.

(1b) Optimization procedure for parameters – and will follow item 1a.



Tentative success generating SPM vendor interest.

(2) Overview of non-topographic contrast and artifacts in AFM imaging.



Tri-National Needs Perceived by SG3 Chair

From the perspective of North American cooperation within international standards bodies, the Chair of ISO/TC201/SC9/SG3 perceives several needs:

- *Mexican/Canadian SPM Expert participation in SC9 (Note that neither Canada or Mexico is P or O member of TC201 – but this only affects voting rights. Participation of non-member experts is allowed/encouraged by ISO paradigm)*
- *Industry or user-targeted US and/or North American ‘mirror’ of SC9 – and hold satellite meetings in conjunction with relevant SPM conferences. (Chair is regular at SPIE Advanced Litho – but this may not be optimal venue. Current ASTM E42 mirror is held with AVS.) Chair hopes to explore SEMI liaison.*



Tri-National Needs Perceived by SG3 Chair

From the perspective of North American cooperation within international standards bodies, the Chair of ISO/TC201/SC9/SG3 perceives several needs:

- *Formal ISO liaison between TC213 and TC201 - US/ANSI is only P member of both – NIST has personnel deployed within TC213 and TC201 and may be well positioned to drive such cooperation. (Currently, only TC202 has TC201 liaison.)*
- *There is a general perception in some sectors that the European delegations to ISO have had more success getting their standards adopted in contexts relative to trade with the Far East. Tri-national cooperation could help bolster North American influence in this arena.*



Broader Perceptions of SG3 Chair

From a broader perspective – including North American cooperation- the Chair of ISO/TC201/SC9/SG3 observes:

- *The risk of limited relevance appears to exceed the risk of standards output detrimental to North American interests.*
 - *SC3 file format – limited vendor participation.*
- *Some of the other national delegations to TC201/SC9 appear to place a relatively lower priority on broad-based engagement and buy in to committee standards activities.*
- *Optimum strategy for protection of our Tri-National interests vis-à-vis ISO/TC201 is unclear – but expanded North American cooperation could be beneficial.*



Recap of Possible Discussion Points for at Tri-National Workshop

- **SC9 experts from Canada and Mexico. *Further suggestions from those delegations?***
- **Tri-national SC9 mirror group & possible SPM conference linkage with satellite meetings. *What conference venues have broadest relevant tri-national participation?***
- **Formal liaisons between TC201/TC213 and/or TC229 – driven by US/ANSI/NIST?**
- **Other issues?**



Acknowledgements

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NIST/OMP – Jack Martinez, Yaw Obeng

Scientific Collaborators:

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Extra Slides



NIST

Current SG3 Membership: *P-Member Countries (1)*

China:

Dian Hong Shen
Xing Zhu
Jun Hu
Guangyi Shang
Wen Hao Huang

Japan:

Jiping Ye
Shinichi Kitamura
Ken Nakajima
Kenichi Ishikawa
Tomizo Kurosawa
Daisuke Fujita
Ichiko Misumi

Russia:

Valery Ryabokon
Alexei Temiryayev
Sergey Mezhuev
Sergey Saunin

Korea:

Haeseong Lee
Jae Heyg Shin
Dal-Hyun Kim
Sang Jung Ahn



Current SG3 Membership: ***P-Member Countries (2)***

Germany:

Ludger Koenders
Thorsten Dziomba

Hungary:

Laszlo Biro
Laszlo Kover

United Kingdom:

Martin Seah
Charles Clifford
Jane Haycocks
Peter Cumpson
Graham Leggett
Peter Doyle
Peter Zhdan
Andrew Yacoot

United States:

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Joe Griffith
Gregory Meyers
Don Baer
John Kramar
John Villarrubia
Joseph Fu
Marc Osborn
George Orji
Scott Lea
Robert Cook
Jaroslaw Grobelny
John Woodward



Current SG3 Membership: *O-Member Countries*

Australia:

Ian Gentle

Austria:

*No current members
Suggestions welcome*

France:

*No current members
Recruitment in Progress*

Finland:

*No current members
Suggestions welcome*



Current SG3 Membership: *Non-Member Countries*

Brazil:

Mônica Alonso Cotta

Mexico:

No current members
Suggestions welcome

South Africa:

Sam Thema

Canada:

Jennifer Decker
Brian Eves
Cynthia Goh
James Pekelsky

