

Some information about NC-AFM

Dear Colleague.

For a national workshop about NC-AFM, which I organized in March 2008 in *La Londe des Maures* (France), I prepared this small information note. In this document you will find some useful information about people, who are involved in NC-AFM, some companies, which produce NC-AFM's, tips and software, and some hints towards good literature.

Note, that not all information about NC-AFM can be supplied!

This document will be sometimes updated in order to add missing information. If you want to have something corrected or improved, please, send me an Email (barth@cinam.univ-mrs.fr). Thank you.

I hope that you much enjoy NC-AFM.

Best wishes,

Clemens Barth.

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1. Colleagues worldwide

There are already many colleagues worldwide, who are more or less active in NC-AFM. It could be that some of them are not listed here because I have overseen them, I'm sorry. Further, it needed a lot of time and much effort to analyze and list all the subjects, on which the colleagues work.

So, please let me know, if there is something missing. Send an Email to: barth@cinam.univ-mrs.fr. Thank you.

In alphabetical order:

Directeur de Recherche, Dr. Jean-Pierre Aimé

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• AFM Active Nanoprobe, Nanomechanics at the interface : nanorheology and nanohydrodynamics, modeling AFM dynamics and hydrodynamics

Ass. Prof. Dr. Toyoko Arai

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• In general: atomic resolution imaging NC-AFM on Si(111) 7x7, tip preparation

Ass. Prof. Dr. Roland Bennewitz (Bennewitz group – Montreal (Canada))

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• In general: atomic resolution imaging NC-AFM (alkali halides), now nanotribology (alkali halides)

Prof. Dr. Besenbacher (Besenbacher group – Aarhus (Denmark))

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- In general: Nanocatalysis, NC-AFM: atomic resolution imaging on TiO₂ + contrast interpretation

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- In general: Nanocatalysis, NC-AFM: Imaging of nanocluster systems on Al₂O₃, organizer of the NC-AFM 2004

Dr. Jaime Colchero Páez

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- In general: Nanotechnology, tapping AFM, KPFM, one of the developers of the Nanotec microscope

Prof. Dr. Sam Fain (Fain/Campbell group – Seattle (USA))

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- In general: Nanocatalysis, NC-AFM: Imaging of nanocluster systems (Al₂O₃), theory, organizer of the NC-AFM 2004

Dr. Adam Foster (Foster group – Helsinki (Finland))

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- In general: theory in NC-AFM even at *ab-initio* level (CaF₂, TiO₂, NaCl, CeO₂, MgO, molecules on surfaces, nanoclusters, etc.)

Prof. Dr. Hans-Joachim Freund (Freund group – Berlin (Germany))

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- In general: Nanocatalysis, tuning fork NC-AFM on MgO(001)

Dr. Ricardo Garcia (Garcia group – Barcelona (Spain))

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- Nanotechnology, scanning probe in general, tapping AFM , organizer of the NC-AFM 2008

Lehrstuhl Prof. Dr. F. J. Giessibl (Giessibl group – Regensburg (Germany))

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- In general: Atomic resolution NC-AFM imaging (Si, NiO, alkali halides), theory of NC-AFM, first who got atomic resolution in NC-AFM, higher harmonic NC-AFM at atomic scale

Dr. Thilo Glatzel (Meyer/Güntherodt group – Basel (Switzerland))

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Web : <http://www.hmi.de/bereiche/SE/SE2/arbeitsg/analytik/nano/index.html>

- In general: KPFM (semiconductor (solar cells) in the Lux-Steiner group, now also atomic resolution imaging in Meyers group on thin KBr films + molecules

Dr. Benjamin Grevin

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- Tuning for NC-AFM in high vacuum, molecules (polymer thin films)

Prof. Dr. Peter Grütter (Grütter group – Montreal (Canada))

NanoScience & Scanning Probe Microscopy Group

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• In general: Nanotechnology, nanoclusters on alkali halide surfaces, now also atomic resolution imaging, organizer of the NC-AFM 2002

Prof. Dr. Hartmann (Hartmann group – Saarbrücken (Germany))

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Postfach 151150
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• In general: Nanotechnology, gold nanoclusters

Associated Prof. Dr. Yukio Hasegawa (Hasegawa group – Kashiwa (Japan))

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Web : <http://hasegawa.issp.u-tokyo.ac.jp/index-e.htm>

• In general: Atomic resolution NC-AFM imaging on semiconducting surfaces (Si(111) 7x7, Ge/Si(105))

Dr. Regina Hoffmann-Vogel (Meyer/Güntherodt group – Basel (Switzerland))

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• In general: Atomic resolution NC-AFM imaging with a LT-AFM/STM, force spectroscopy, alkali halides, NiO

Prof. Dr Hans-Josef Hug (Hug/Güntherodt group – Basel (Switzerland))

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Web : http://www.empa.ch/plugin/template/empa/991/*/--/l=2

• In general: Atomic resolution NC-AFM imaging with a LT-AFM/STM, force spectroscopy, alkali halides, NiO, Si(111) 7x7, today: Forces, surfaces and magnetism with the AFM

Prof. Dr. Iwasawa (Iwasawa group – Tokyo (Japan))

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• In general: Catalysis, atomic resolution NC-AFM imaging on CeO₂(111)

Prof. Dr. Suzan Jarvis (Jarvis group – Dublin (Ireland))

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• In general: molecules at the nanometer scale, air NC-AFM imaging, theory about NC-AFM techniques

Dr. Lev Kantorovich (Kantorovich group – London(England))

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• In general: theory in NC-AFM even at *ab-initio* level, theory of damping

Dr. Franciszek Krok (Szymonski group – Krakow (Poland))

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Web : <http://www.if.uj.edu.pl/ZFD/index.php>

• In general: NC-AFM on alkali halides and semiconductors, nanoclusters, much KPFM

Dr. Tobias Kunstmann (Möller group – Duisburg-Essen (Germany))

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Web : de/forschung/reibung-und-daempfung-auf-atomarer-skala.html

• In general: Atomic resolution NC-AFM imaging on KBr, tribology

Prof. Dr. Christian Loppacher Voirol (Loppacher group – Marseille (France))

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• In general: NC-AFM and KPFM on thin alkali halide films grown on metal surfaces, molecules, atomic resolution imaging

Prof. Dr. Martha Ch. Lux-Steiner (Lux-Steiner group – Berlin (Germany))

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• In general: photovoltaic (solar cells), much KPFM on semiconductors (solar cells), theory of KPFM

Prof. Dr. Ernst Meyer / H.-J. Güntherodt (Meyer/Güntherodt group – Basel (Switzerland))

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• In general: AFM/STM, atomic resolution imaging NC-AFM (alkali halides, semiconductors, metals, molecules etc.), KPFM, Nanotribology, Nanotechnology, organizer of the NC-AFM 1999

Prof. Dr. Morita (Morita group – Osaka (Japan))

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• In general: atomic resolution NC-AFM imaging on semiconductors (Si), a bit on alkali halides, CeO₂, molecules etc., a little bit KPFM, first organizer of the NC-AFM 1998

Prof. Dr. Hiroshi Onishi (Onishi group – Kobe (Japan))

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- In general: Nanocatalysis, atomic resolution NC-AFM imaging on TiO₂, organizer of the NC-AFM 2006

Prof. Dr. Marjorie Olmstead (Olmstead group – Seattle (USA))

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- In general: Nanotechnology, atomic resolution NC-AFM imaging on CaF₂(111) thin films

Ass. Prof. Dr. Ahmet Oral (Oral group – Ankara (Turkey))

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- In general: Nanotechnology, atomic resolution NC-AFM imaging on semiconductor surfaces, organizer of the NC-AFM 2007

Prof. Dr. Ruben Perez (Perez group – Madrid (Spain))

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- Theoretical study of the operation of the scanning probe microscopes: scanning tunneling microscope (STM) and atomic force microscope (AFM), atomic contrast, energy dissipation mechanisms and nanomanipulation, organizer of the NC-AFM 2008

Prof. Dr. John Pethica (Pethica group – Dublin (Ireland))

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- In general: Nanotechnology, atomic resolution NC-AFM imaging on semiconductor surfaces, organizer of the NC-AFM 2003

Prof. Dr. Plummer (Plummer group – Tennessee (USA))

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- In general: Nanotechnology, NC-AFM imaging nanoclusters on alkali halide surfaces

Prof. Dr. Michael Reichling (Reichling group – Osnabrück (Germany))

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- In general: Atomic resolution NC-AFM imaging on CaF₂(111), CeO₂(111), Al₂O₃, a bit molecules and catalysis, manipulation, organizer of the NC-AFM 2005

Dr. Sascha Sadewasser (Lux-Steiner group – Berlin (Germany))

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- In general: much KPFM on semiconductors (solar cells), theory of KPFM

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- In general: KPFM on bulk alkali halide crystals under environmental conditions (water vapour)

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- In general: Atomic resolution NC-AFM imaging, HOPG, much nanotribology also

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- In general: Nanotechnology, atomic resolution NC-AFM imaging (NiO), much magnetic AFM, spin contrast

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- In general: theory in NC-AFM even at *ab-initio* level (CaF₂, TiO₂, NaCl, CeO₂, MgO, molecules on surfaces, nanoclusters, etc.)

Prof. Dr. Ivan Stich (Stich group – Bratislava (Slovakia))

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- In general: theory in NC-AFM even at *ab-initio* level (semiconductors)

Prof. Dr. Yasuhiro Sugawara (Sugawara group – Osaka (Japan))

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- In general: atomic resolution NC-AFM imaging on semiconductor surfaces (Si)

Prof. Dr. Marek Szymonski (Szymonski group – Krakow (Poland))

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- In general: alkali halides, atomic resolution NC-AFM imaging of alkali halides and semiconductors, nanoclusters, expert in KPFM

Prof. Dr. Masahiko Tomitori (Tomitori group – Ishikawa (Japan))

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- Atomic resolution NC-AFM imaging on Silicon

Prof. Dr. Roland Wiesendanger (Wiesendanger group – Hamburg (Germany))

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- In general: Nanotechnology, STM/AFM, atomic resolution NC-AFM imaging (semiconductors, NiO, HOPG, Xe films), Magnetic AFM, organizer of the NC-AFM 2000

2. Literature

In order to get a good access to NC-AFM, the review of Franz Giessibl is the best starting point.

F. Giessibl, *Rev. Mod. Phys.* **75** p1 (2003)

Another review would be the one from Garcia and Perez

R. Perez and Garcia, *Surf. Sci. Rep.* **47** p197 (2002)

For theory, at even *ab-initio* level, the one from Hofer, Foster and Shluger should be used.

Hofer, Foster, Shluger, *Rev. Mod. Phys.* **75** p1287 (2003)

In order to get a very good scientific overview of what can be done with the NC-AFM technique, the book "Noncontact AFM" should be bought:

Morita, Meyer, Wiesendanger (Eds.), *Noncontact AFM* (2002, Springer-Verlag, Berlin)

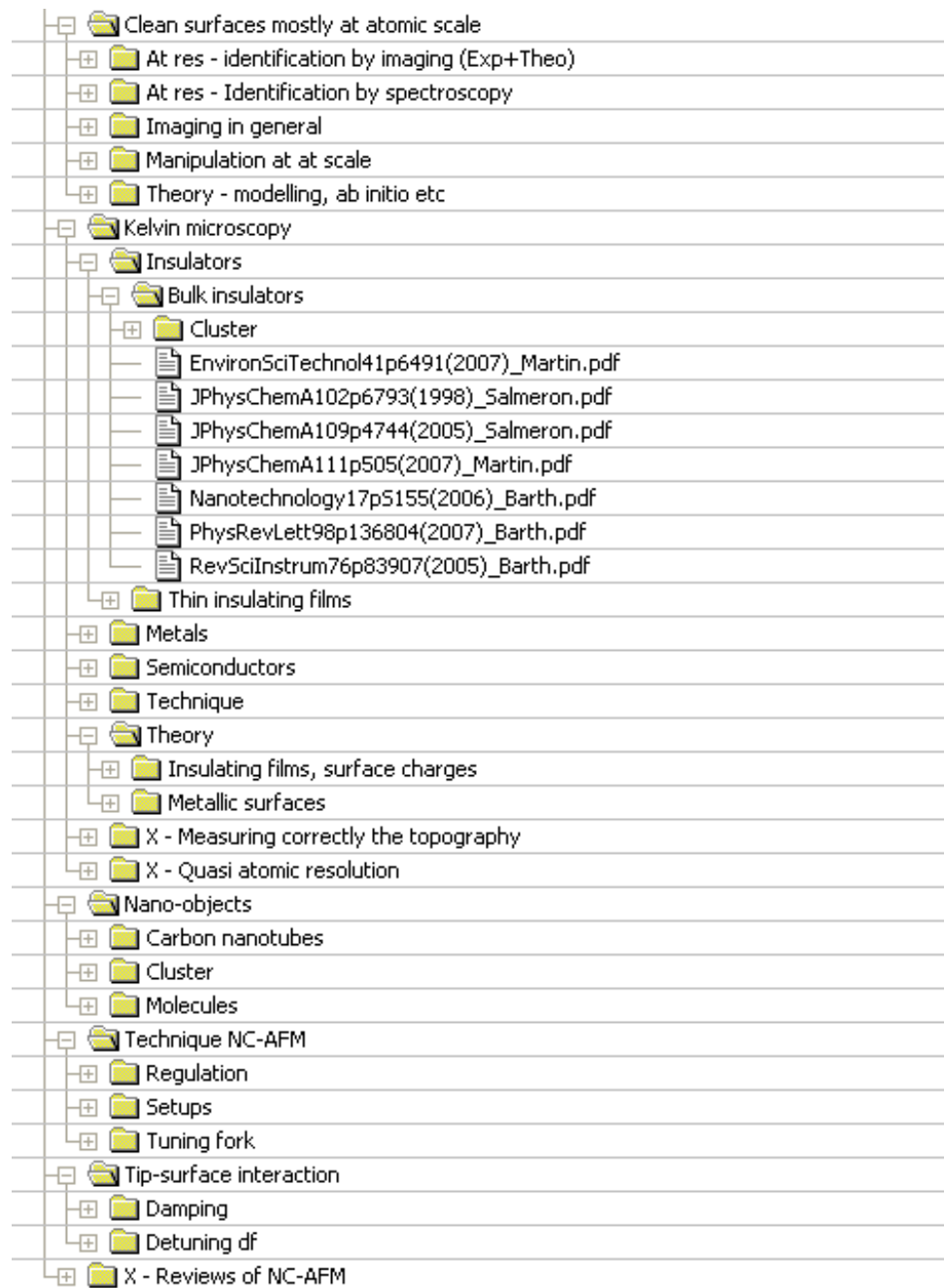
Almost all important researchers contributed to this book some years ago.

Unfortunately, I'm not allowed to put pdf documents of my library onto an Internet server due to copyright reasons of the journals. The articles have to be downloaded at your institution.

However, I took some screen shots of my small library, which are show on the following pages. Note that this library does not include all literature! The best is to search NC-AFM in connection with the subject of interest (e.g. with ISI Web of knowledge). Here is a possible search string for NC-AFM:

("NC-AFM" OR "Noncontact AFM" OR "Non-contact AFM" OR "Dynamic Scanning Force Microscopy" OR "dynamic SFM" OR "Frequency modulation" AFM OR DSFM OR DFM OR "Dynamic Force Microscopy" OR "Dynamic AFM") AND **"subject of interest"**

Main directory



- [-] Clean surfaces mostly at atomic scale
 - [-] At res - identification by imaging (Exp+Theo)
 - CaF2_JPhysCM13(10)p2061(2001)_Barth.pdf
 - CaF2_PhysRevB66p235417(2002)_Barth.pdf
 - CaF2_PhysRevLett86p2373(2001)_Barth.pdf
 - KBr_Nanotechnology19p045503(2008)_Gauthier.pdf
 - NaCl_PhysRevB62p(2000)_Shluger.pdf
 - Nanotechnology19p045503(2008)_Gauthier.pdf
 - TiO2_Nanotechnology17p3436(2006)_Besenbacher.pdf
 - TiO2_PhysRevB76p205415(2007)_Besenbacher.pdf
 - [-] At res - Identification by spectroscopy
 - CaF2(111)_JAmChemSoc127p17863(2005)_Barth.pdf
 - Doped Si_Nature446p64(2007)_Custance.pdf
 - HOPG_Nanotechnol16p5134(2005)_Wiesendanger.pdf
 - KB(001)r_PhysRevLett92p146103(2004)_Guntherodt.pdf
 - NiO(001)_PhysRevB67p85402(2003)_Hoffmann.pdf
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 - Ag(110)_PhysRevB77p045411(2008)_Fuchs.pdf
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 - CeO(111)_JPhysChemB107p11666(2003)_Iwasawa.pdf
 - CeO2(111)ApplSurfSci188p252(2002)_Fukui.pdf
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 - GaAs(110)_PhysRevB76p245314(2007)_Szymonski.pdf
 - Ge(111)_Nanotechnology16p568(2005)_Morita.pdf
 - HOPG_ApplSurfSci140p247(1999)_Wiesendanger.pdf
 - InAs(110)_ApplSurfSci140p293(1999)_Wiesendanger.pdf
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 - MgO_PhysRevLett91p196102(2003)_Barth.pdf
 - NaCl(001)_PhysRevLett97p136101(2006)_Fuchs.pdf
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 - X - Readme.doc
- [-] Kelvin microscopy
 - [-] Insulators
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 - PhysRevLett98p136804(2007)_Barth.pdf
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 - JApplPhys97p63709(2005)_Schmitz.pdf
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 - PhysRevLett95p226105(2005)_Colchero.pdf
 - SurfSci566-568p63(2004)_Szymonski.pdf
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 - PhysRevB53p8065(1995)_DeMejo.pdf
 - PhysRevB64p245403(2001)_Baro.pdf
 - PhysRevB74p85413(2006)_Butt.pdf
 - X - Measuring correctly the topography
 - Nanotechnology15p514(2004)_Lux-Steiner.pdf
 - PhysRevB74p193313(2006)_Chiang.pdf
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 - X - Quasi atomic resolution
 - ApplSurfSci188p381(2002)_Morita.pdf
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 - Nanotechnology17p4204(2006)_Gauthier.pdf
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- X - Reviews of NC-AFM
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 - RevModPhys75p1287(2003)_Shluger.pdf
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- PhysRevB76p075423(2007)_Szymanski.pdf
- Small3p818(2007)_Grutter.pdf
- SurfSci460pL510(2000)_Thornton.pdf
- Molecules
 - ApplPhysA72p5109(2001)_Matsushige.pdf
 - ApplSurfSci157p244(2000)_Morita.pdf
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 - PhysRevLett90p66107(2003)_Loppacher.pdf
- Readme.doc
- Technique NC-AFM
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 - Nanotechnology18p084017(2007)_Gauthier.pdf
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 - RevSciInstr77p083701(2006)_Fuchs.pdf
 - Science305p380(2004)_Giessibl.pdf
 - Tip-surface interaction
 - Damping
 - ApplPhysA72p(2000)_Couturier.pdf
 - Nanotechnology16p901(2005)_Bennetau.pdf
 - Nanotechnology18p084017(2007)_Gauthier.pdf
 - PhysRevB6011051(1999)_Fuchs.pdf
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 - PhysRevLett85(25)p5348(2000)_Gauthier.pdf
 - PhysRevLett89p146104(2002)_Gauthier.pdf
 - PhysRevLett96p106101(2006)_Custance.pdf
 - Detuning df

Part 4

3. Manufacturers of NC-AFM's and other links

Note that on the Internet sites of the manufacturers, the national suppliers can be found quite easily.

UHV NC-AFM's

Worldwide, there are mainly three manufacturers for UHV NC-AFM's. World leader is the company Omicron, followed by JEOL and RHK.

Omicron

NanoTechnology GmbH

Limburger Str. 75

65232 Taunusstein

Germany

Tel : 06128/987-0

Fax : 06128/987-185

Email : info@omicron.de

Web : <http://www.omicron.de/>

RHK Technology

1050 East Maple Road

Troy, MI 48083

USA

Tel : 248-577-5426

Fax : 248-577-5433

Email : info@rhk-tech.com

Web : <http://www.rhk-tech.com/>

JEOL Ltd.

Main Office: JEOL Ltd.

1-2, Musashino 3-chome Akishima

Tokyo 196-8558

Japan

Tel. : +81-42-543-1111

Fax : +81-42-546-3353

Web : <http://www.jeol.com/>

AFM tip makers

NANOSENSORS

Rue Jaquet-Droz 1

Case Postale 216

CH-2002 Neuchatel

Switzerland

phone : +41 (0)32 720 5085

fax : +41 (0)32 720 5792
e-mail : info@nanosensors.com
Web : <http://www.nanosensors.com/>

NT-MDT Co.

Post Box 158
Building 317-A
Zelenograd, Moscow 124482,
Russia
Tel.: +7 (495) 535-0305
+7 (495) 535-8369
+7 (495) 535-2493
Fax: +7 (495) 535-6410
Web : <http://www.ntmdt.com/>

MikroMasch

Sales office responsible for the USA, Canada and Mexico.
111 N.Market Str.
San Jose, CA 95113
USA
Fax : (919) 869-2443
Fax : (503) 296-2381
Phone : (866) 776-8477 (SPMTIPS)
Web : <http://www.spmtips.com/>

Software

There is already a vast amount of software, which can be used in principle. Here are a few programs that might be useful:

WSxM

Nanotec Electronica S. I.
Entro Empresarial Euronova 3
Ronda de Poniente 2
Edificio 2, planta 1ª, oficina A
E28760 Tres Cantos (Madrid) SPAIN
Phone : +34-918043347, +34-918043326
Fax : +34-918043348
Web : <http://www.nanotec.es/>

NIH - Image

Web : <http://rsb.info.nih.gov/nih-image/>

Image Metrology (SPIP)

Web : <http://www.imagemet.com/>

4. Speakers of the Atelier NC-AFM 2008

Directeur de Recherche Dr. Sebastian Gauthier

CEMES-CNRS
29 rue J Marvig
PO Box 94347
F-31055 Toulouse
France

Tel. : 05.62.25.79.80

Fax : 05.62.25.79.99

E-mail : gauthier@cemes.fr

Web : http://www.cemes.fr/r1_lab/gauthier.htm

- In general: STM, but now also atomic resolution NC-AFM imaging (alkali halides), NC-AFM on TiO₂(110), molecules and MoS₂ + supported nanocluster), theory of NC-AFM technique, damping,

Dr. Laurent Nony

L2MP
Faculté des Sciences et Techniques
Avenue Normandie Niemen
Service 151
13397 Marseille Cedex 20
France

Tel. : 04.91.28.89.97

Fax : 04.91.28.87.75

E-mail : laurent.nony@l2mp.fr

Web : <http://www.l2mp.fr/perso/nony.html>

- In general: NC-AFM and KPFM of molecules, alkali halides, theory of NC-AFM and tapping AFM technique, damping

Dr. Laurent Pham Van

CEA Saclay
DSM/DRECAM/SPCSI
F-91191 Gif-sur-Yvette Cedex
France

Tel. : 01.69.08.41.48 / 84.92

Fax : 01.69.08.84.46

E-mail : phamvan@drecam.cea.fr, laurent.pham-van@cea.fr

Web : http://www-drecam.cea.fr/en/Phoce/Vie_des_labos/Ast/ast_service.php?id_unit=445

- In general: Tuning fork NC-AFM in air, Al₂O₃, organic films

Dr. Clemens Barth (Organizer of the NC-AFM atelier)

CINAM – CNRS
Campus de Luminy
Case 913
13288 Marseille Cedex 09
France

Tel. : 06.60.36.28.19

Fax : 04.91.41.89.16

E-mail : barth@cinam.univ-mrs.fr

Web : <http://www.crmcn.univ-mrs.fr/barth/default.htm>

- In general: Atomic resolution NC-AFM imaging (CaCO₃, CaF₂, Al₂O₃, MgO, KBr, NaCl, KCl), imaging nanocluster systems, KPFM on bulk insulating surfaces + supported nanocluster