

Curriculum Vitae Dr. rer. nat. Oliver S. Gröning

Personal data

Name Oliver Sauro Gröning
Title Doctor rerum naturalium (Experimental Physics)
Born 20th of April 1969 in Solothurn, Switzerland
Nationality Swiss
Civil status Single

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Languages German, English and French fluent in speaking and writing; Italian fluently spoken
Google scholar ID: <https://scholar.google.com/citations?user=sBokx24AAAAJ&hl=en>

Education

1994-1999 Dissertation in the Solid State research group of Prof. Louis Schlapbach at the University of Fribourg. Thesis title: "Field emission properties of carbon thin films and carbon nanostructures", degree earned with distinction of the jury

1989-1994 Study of Physics and Mathematics at the University of Fribourg (Switzerland), graduated with the diploma thesis entitled: "Characterization of thermionic electron emitters by photoelectron spectroscopy"

Professional Experience

2014 Promotion as **Distinguished Senior Researcher** at Empa, nanotech@surfaces Laboratory

2011 Promotion as **Deputy Section Head** at Empa, nanotech@surfaces Laboratory

2007 Promotion as **Senior Scientist** at Empa, nanotech@surfaces Laboratory

2004 Promotion as **Group Leader** at Empa with research focus on:

- Investigation of electronically active defects on carbon nanotubes
- Molecular self-assembly on nano-template surfaces
- Surface properties of quasicrystals and complex metallic alloys

2001 - 2003 Project leader at Empa, Thun

- Management of the CTI-funded project "Controlled growth of carbon nanotubes in chemical vapor deposition"
- Management of a work package in the 5th frame work EU-Project CANVAD "Carbon Nanotube for Microwave Vacuum Devices"
- Evaluation and installation of a UHV LT-STM system at Empa, Thun.
- Preparation of the foundation of the new nanotech@surfaces Laboratory at Empa, which became operational 03.01.2003

- 1999 - 2000 Post-Doc in the Solid State research group of Prof. Louis Schlapbach, University of Fribourg
- Development of a UHV scanning anode field emission microscope collaboration with Motorola Research
 - Controlled growth of carbon nanotubes
 - Holding lectures in the frame work of the BENEFRi materials science and technology course

Approved Research Projects since 2013

- Nano-Terra: "Tunable Carbon Nanotube Electro-Mechanical Resonators" (CabTuRes, 2011 - 2013)
- ERC-Empa COFUND: "Boron-Nitride – Nanocarbon Hybrid Materials" (BONMAT, 2013 - 2016)
- SNF 200021-149627: "Molecular Surface Science on Ultra-Thin Insulator" (MOSSUL, 2014 - 2016)
- Empa internal research call: "Low-Temperature Atomic Scale Scanning Probe Characterization of Quantum Devices" (AtomSparQ, 2016 - 2019)
- EU-Project / H2020-EU.2.1.1.: "Piezoelectronic Transduction Memory Device" (PETMEM, 2015 - 2019)
- SNF 200021-165512: "Probing 2D materials interaction with Graphene Quantum Dots" (PIQuaDo, 2017 - 2023)
- Empa internal research call: "Functional Molecule - Graphene Nanoribbon Hetero-Structures" (FUMGRA, 2019 - 2023)
- SNF 206021-205299: "Scanning Probe Microscopy for Quantum Spin Systems" (SPM4QSS, 2021 – ongoing)
- Werner Siemens Stiftung: "Carbon Nanomaterials for Quantumtechnologies of the 2nd Generation "
- (CarboQuant, 2022 – ongoing)

Supervision of junior researchers at graduate/ postgraduate level since 2013

- 6 PhD Students (Dr. R. Addou, Dr. J. Prinz, Dr. S. Stolz, Dr. Y. Popoff, Mr. M. Bommert)
- 6 Post-Doc (Dr. R. Jaafar, Dr. L. Liu, Dr. Th. Dienel, Dr. G. Günzburger, Dr. B. Schuler, Dr. N. Merino-Diez)
- 1 Master Student (Mr. Y. Forrer)

Committees, Review Panels

Various national and international assignments as expert on Master-, PhD-Thesis, SNF-, EU-FP-, CNRS-, CAS- and ERC-project evaluation committees.

- 2006 - 2014 Member of the Free Electron Laser Advisory Committee of the Swiss-FEL project (PSI)
- 2009 - to date Member of the jury for the Swiss Technology Award
- 2010 - to date Person of Trust for matters of Research Integrity at Empa
- 2017 - to date Member of the Swiss Light Source Proposal Review Committee (SLS-PRC)
- 2019 - to date Member of the 'Ambizione' program evaluation committee of the Swiss National Science Foundation

Dübendorf, 18.01.2024



Major Scientific Achievements

Dr. Oliver Gröning is Deputy Head of the nanotech@surfaces Laboratory at the Swiss Federal Laboratories for Materials Science and Technology (Empa). He has published over 160 peer reviewed journal articles with over 8'700 citations (h-index 46 / Scopus). His research covers the fields from surface science investigations of complex metallic alloys and quasi crystals, molecular self-assembly on template surfaces to the investigation of defect structures in CNTs and the modification to the electronic structure they induce. Oliver Gröning is an internationally renowned expert in the electron emission properties of nanocarbon structures. He has exploited this expertise in numerous projects with industrial partners such as Motorola (Phoenix, USA), SONY (Atsugi, Japan), Philips (Aachen, Germany), Thales LCR (Paris, France) and COMET AG (Flamatt, Switzerland).

In the last 13 years the nanotech@surfaces Laboratory of Empa has acquired a broad expertise in the investigation of molecular nanostructures on surfaces with a strong emphasis on the following topics: hydrogen-bond directed supramolecular self-assembly, interaction of molecules with functional surfaces (i.e. surfaces exhibiting large scale properties modulations like strain-relief pattern or regular step sequences), on-surface synthesis of atomically precise nanostructures, electronic properties characterization of nanostructures at surfaces, surface structure and electronic properties of complex metallic alloys and the investigation of intermetallic surface structure and chemistry for catalytic applications. In June 2014 Dr. O. Gröning has been appointed first Distinguished Senior Research at Empa.

In the context of the present proposal the activities of the laboratory on on-surfaces synthesis of novel, atomically precise carbon nanostructures are of particular relevance. A further major achievement of the nanotech@surfaces Laboratory has been the pioneering work on the synthesis and electronic structure characterization of 1D graphene derived nanostructures, so-called graphene nanoribbons (GNR). The electronic and magnetic properties of GNRs critically depend on their atomic structure, in particular the shape of their edges, which can vary from armchair, to chiral or zigzag.

In 2018 we achieved a significant breakthrough in showing experimentally and by simulation that topologically non-trivial electronic phases and states can be rationally engineered in GNR structures [O. Gröning et al., Nature 560, 209 (2018)]. Figure 1 summarizes this achievement by comparing ultra-high STM imaging of a GNR hetero structure and STS spectroscopy of its electronic properties with corresponding electronic structure simulations. Specifically the occurrence of localized topological junction states has been proved. A feature of these states is that they can undergo spin-polarization due to Coulomb repulsion (Mott-Hubbard). This ability to design the configuration of such spin polarized states the vision to fully engineer not just electronic, but indeed magnetic phases has become possible.

In the mean time we could indeed show that this vision can be put to reality in the following publications:

S. Mishra et al., "Synthesis and Characterization of pi-Extended Triangulene", JACS 141, 27, 10621 (2019)

S. Mishra et al., "Topological Defect-Induced Magnetism in a Nanographene", JACS 142, 3, 1147 (2020)

S. Mishra et al., "Topological frustration induces unconventional magnetism in a nanographene", Nature Nanotechnology, 15, 1, 22 (2020)

Additionally we could show that the concept of engineering topological phases can also be applied to the synthesis of quasi-metallic polymer at the trivial to non-trivial topological phase transition.

B. Cirera et al., "Tailoring topological order and π -conjugation to engineer quasi-metallic polymers", Nature Nanotechnology, 15, 437 (2020)

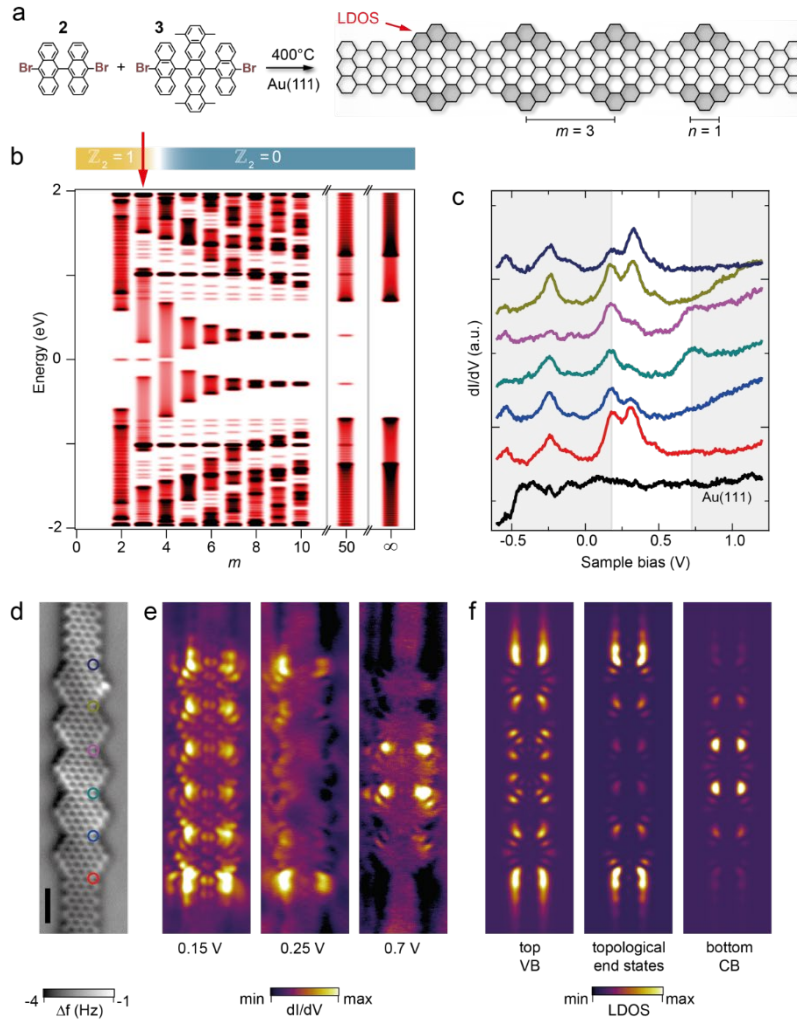


Figure 1 | Non-trivial topological ($\mathbb{Z}_2 = 1$) phase of the inline edge-extended 7-AGNR-I(1,3) structure. **a**, On-surface synthesis route to the 7-AGNR backbone extended 7-AGNR-I(1,3) nanoribbon. **b**, LDOS plots evaluated at the end of the 7-AGNR-I(1, m) segment (see arrow in **a**) as a function of inter-segment spacing m , revealing the $\mathbb{Z}_2 = 1$ to $\mathbb{Z}_2 = 0$ transition at $m = 4$ with nearly complete gap closure and disappearance of the zero energy states for $m > 3$. **d**, Constant-height nc-AFM frequency shift (Δf) image of a 5 unit 7-AGNR-I(1,3) segment with 7-AGNR extensions at both ends. **c**, dI/dV spectra (-0.6 V and 100 pA set-point before opening feedback loop) taken at the locations indicated by the markers of corresponding color in (**d**). **e**, Experimental dI/dV maps of the main spectroscopic features at +0.15 V, +0.25 V and +0.7 V (all with $I=500$ pA). **f**, TB simulated charge density maps at the top of the VB, at $E=0$ eV, and at the bottom of the CB, computed for the experimental structure (**d**). [from O. Gröning et al., Nature 560, 209 (2018)]

Publications of the last 5 years (2019-2024)

Last updated: January 2024

Total published papers: 170 (papers not peer reviewed are marked with a *)

Web of Science Researcher ID: J-9727-2012

(<http://www.researcherid.com/rid/J-9727-2012>)

Scopus listed research output: 169 Publications >8700 Citations H-Index: 46

2024

170 Ambipolar charge transfer of larger fullerenes enabled by the modulated surface potential of h-BN/Rh(111)

M. Bommert, B. Schuler, C. A. Pignedoli, R. Widmer, O. Gröning
Carbon 216, 118592 (2023). DOI: 10.1016/j.carbon.2023.118592

2023

169 Spin-stabilization by Coulomb blockade in a vanadium dimer in WSe₂

S. Stolz, B. Hou, D. Wang, A. Kozhakhmetov, C. Dong, O. Gröning, J. Robinson, D. Y. Qiu, B. Schuler
ACS Nano 17, 23, 23422–23429 (2023). DOI: 10.1021/acsnano.3c04841

168 On-surface synthesis of edge-extended zigzag graphene nanoribbons

A. Kinikar, X. Xu, M. Di Giovannantonio, O. Gröning, K. Eimre, C. A. Pignedoli, K. Müllen, A. Narita, P. Ruffieux, R. Fasel
Adv. Mater. 2306311 (2023). DOI: 10.1002/adma.202306311

167 Electronic Decoupling and Single-Molecule Charging of C₆₀ on h-BN/Rh(111)

M. Bommert, G. Günzburger, R. Widmer, B. Schuler, O. Gröning
Europhys. News 53, 4 (2022). DOI: 10.1051/eprn/2022405

2022

166* When a molecular motor does the quantum leap

O. Gröning, S. Stolz, J. Prinz, H. Brune, R. Widmer
Europhys. News 53, 4 (2022). DOI: 10.1051/eprn/2022405

165 Layer-dependent Schottky contact at van der Waals interfaces: V-doped WSe₂ on graphene

S. Stolz, A. Kozhakhmetov, C. Dong, O. Gröning, J.A. Robinson, B. Schuler
npj 2D Mater. Appl. 6, 66 (2022). DOI: 10.1038/s41699-022-00342-4

164 On-surface Synthesis: What Happens Behind the Scenes?

S. Stolz, M. Di Giovannantonio, O. Gröning, R. Widmer
Chimia 76 (3), 203-211. DOI: 10.2533/chimia.2022.203

163 On-surface synthesis and characterization of nitrogen-substituted undecacenes

K. Eimre, J.I. Urgel, H. Hayashi, M. Di Giovannantonio, P. Ruffieux, S. Sato, S. Otomo, Y.S. Chan, N. Aratani, D. Passerone, O. Gröning, H. Yamada, R. Fasel, C.A. Pignedoli
Nat. Commun. 13, 511 (2022). DOI: 10.1038/s41467-022-27961-1

162 Asymmetric Elimination Reaction on Chiral Metal Surfaces

S. Stolz, M. Danese, M. Di Giovannantonio, J. I. Urgel, Q. Sun, A. Kinikar, M. Bommert, S. Mishra, H. Brune, O. Gröning, D. Passerone, R. Widmer
Adv. Mater. 34 (2), 202104481 (2021). DOI: 10.1002/adma.202104481

2021

161 Large magnetic exchange coupling in rhombus-shaped nanographenes with zigzag periphery

- Shantanu Mishra, Xuelin Yao, Qiang Chen, Kristjan Eimre, Oliver Gröning, Ricardo Ortiz, Marco Di Giovannantonio, Juan Carlos Sancho-García, Joaquín Fernández-Rossier, Carlo A Pignedoli, Klaus Müllen, Pascal Ruffieux, Akimitsu Narita, Roman Fasel
Nat. Chem. 13 (6), 581-586 (2021)
- 160 **Asymmetric azide-alkyne Huisgen cycloaddition on chiral metal surfaces**
Samuel Stolz, Michael Bauer, Carlo A Pignedoli, Nils Krane, Max Bommert, Elia Turco, Nicolò Bassi, Amogh Kinikar, Néstor Merino-Diez, Roland Hany, Harald Brune, Oliver Gröning, Roland Widmer
Commun. Chem. 4, 51 (2021)
- 159 **Controllable p-Type Doping of 2D WSe₂ via Vanadium Substitution**
Azimkhan Kozhakhmetov, Samuel Stolz, Anne Marie Z. Tan, Rahul Pendurthi, Saiphaneendra Bachu, Furkan Turker, Nasim Alem, Jessica Kachian, Saptarshi Das, Richard G. Hennig, Oliver Gröning, Bruno Schuler, Joshua A. Robinson
Adv. Funct. Mater. 2105252 (2021)
- 158 **Metallic carbon nanotube quantum dots with broken symmetries as a platform for tunable terahertz detection**
Gilles Buchs, Magdalena Marganska, Jhon W. González, Kristjan Eimre, Carlo Antonio Pignedoli, Daniele Passerone, Andres Ayuela, Oliver Gröning, and Dario Bercioux
Appl. Phys. Rev. 8, 021406 (2021)
- 157 **Asymmetric azide-alkyne Huisgen cycloaddition on chiral metal surfaces**
Samuel Stolz, Michael Bauer, Carlo A Pignedoli, Nils Krane, Max Bommert, Elia Turco, Nicolò Bassi, Amogh Kinikar, Néstor Merino-Diez, Roland Hany, Harald Brune, Oliver Gröning, Roland Widmer
Commun. Chem., 4 (1), 1 (2021)
- 156 **Graphene nanoribbons with mixed cove-cape-zigzag edge structure**
Prashant P Shinde, Jia Liu, Thomas Dienel, Oliver Gröning, Tim Dumlaff, Markus Mühlinghaus, Akimitsu Narita, Klaus Müllen, Carlo A Pignedoli, Roman Fasel, Pascal Ruffieux, Daniele Passerone
Carbon, 175, 50 (2021)
- 2020**
- 155 **Near-enantiopure trimerization of 9-Ethynylphenanthrene on a chiral metal surface**
Samuel Stolz, Aliaksandr V Yakutovich, Jan Prinz, Thomas Dienel, Carlo A Pignedoli, Harald Brune, Oliver Gröning, Roland Widmer
Angew. Chem. Int. Ed. 132 (41), 18336 (2020)
- 154 **Diradical organic one-dimensional polymers synthesized on a metallic surface**
Ana Sánchez-Grande, José I Urgel, Aleš Cahlik, José Santos, Shayan Edalatmanesh, Eider Rodríguez-Sánchez, Koen Lauwaet, Pingo Mutombo, Dana Nachtigallová, Reed Nieman, Hans Lischka, Bruno de la Torre, Rodolfo Miranda, Oliver Gröning, Nazario Martín, Pavel Jelínek, David Écija
Angew. Chem. Int. Ed. 59 (40), 17594 (2021)
- 153 **Investigating molecular orbitals with submolecular precision on pristine sites and single atomic vacancies of monolayer h-BN**
Liwei Liu, Thomas Dienel, Gino Günzburger, Teng Zhang, Zeping Huang, Cong Wang, Roland Widmer, Wei Ji, Yeliang Wang, Oliver Gröning
Nano Research, 13(8), 2233 (2020)
- 152 **Coupled spin states in armchair graphene nanoribbons with asymmetric zigzag edge extensions**
Qiang Sun, Xuelin Yao, Oliver Gröning, Kristjan Eimre, Carlo A Pignedoli, Klaus Müllen, Akimitsu Narita, Roman Fasel, Pascal Ruffieux
Nano Letters, 20(6), 6429 (2020)
- 151 **Molecular motor crossing the frontier of classical to quantum tunneling motion**
Samuel Stolz, Oliver Gröning, Jan Prinz, Harald Brune, Roland Widmer

- 150 **Resolving Quinoid Structure in Poly(para-phenylene) Chains**
Bingkai Yuan, Can Li, Yan Zhao, Oliver Gröning, Xieyu Zhou, Pengfei Zhang, DanDan Guan, Yaoyi Li, Hao Zheng, Canhua Liu, Yiyong Mai, Peinian Liu, Wei Ji, Jinfeng Jia, Shiyong Wang
J. Am. Chem. Soc. 142 (22), 10034 (2020)
- 149 **Massive Dirac fermion behavior in a low bandgap graphene nanoribbon near a topological phase boundary**
Qiang Sun, Oliver Gröning, Jan Overbeck, Oliver Braun, Mickael L Perrin, Gabriela Borin Barin, Maria El Abbassi, Kristjan Eimre, Edward Dittler, Colin Daniels, Vincent Meunier, Carlo A Pignedoli, Michel Calame, Roman Fasel, Pascal Ruffieux
Adv. Mater. 32 (12), 1906054 (2020)
- 148 **Collective all-carbon magnetism in triangulene dimers**
S. Mishra, D. Beyer, K. Eimre, R. Ortiz, J. Fernández-Rossier, R. Berger, O. Gröning, C.A. Pignedoli, R. Fasel, X. Feng, P. Ruffieux
Angew. Chem. Int. Ed. 59 (29), 12041 (2020)
- 147 **Tailoring topological order and π -conjugation to engineer quasi-metallic polymers**
B. Cirera, A. Sánchez-Grande, B. de la Torre, J. Santos, S. Edalatmanesh, E. Rodríguez-Sánchez, K. Lauwaet, B. Mallada, R. Zbořil, R. Miranda, O. Gröning, P. Jelínek, N. Martín, D. Ecija
Nat. Nanotechnol. 15 (6), 437 (2020)
- 146 **Topological defect-induced magnetism in a nanographene**
S. Mishra, D. Beyer, R. Berger, J. Liu, O. Gröning, J. I. Urgel, K. Müllen, P. Ruffieux, X. Feng, R. Fasel
J. Am. Chem. Soc. 142, 3, 1147 (2020)
- 145 **Topological frustration induces unconventional magnetism in a nanographene**
S. Mishra, D. Beyer, K. Eimre, S. Kezilebieke, R. Berger, O. Gröning, C. A. Pignedoli, K. Müllen, P. Liljeroth, P. Ruffieux, X. Feng, R. Fasel
Nat. Nanotechnol. 15, 1, 22 (2020)

- 142 **On-surface Synthesis and Characterization of Acene-based Nanoribbons Incorporating Four-membered Rings**
C. Sánchez-Sánchez, C. Sánchez-Sánchez, T. Dienel, A. Nicolai, N. Kharche, L. Liang, C. Daniels, V. Meunier, J. Liu, X. Feng, K. Müllen, J. R. Sánchez-Valencia, O. Gröning, P. Ruffieux, R. Fasel
 Chem. Eur. J. 25, 12074 (2019)
- 2018**
- 141 **Engineering of robust topological quantum phases in graphene nanoribbons**
O. Gröning, S. Wang, X. Yao, C. A Pignedoli, G. Borin Barin, C. Daniels, A. Cupo, V. Meunier, X. Feng, A. Narita, K. Müllen, P. Ruffieux, R. Fasel
 Nature 560, 209 (2018)
- 140 **Impact of interlayer application on band bending for improved electron extraction for efficient flexible perovskite mini-modules**
S. Pisoni, F. Fu, R. Widmer, R. Carron, T. Moser, O. Gröning, A. N. Tiwari, S. Bücheler
 Nano Energy 49, 300-307 (2018)
- 139 **Confined electron and hole states in semiconducting carbon nanotube sub-10 nm artificial quantum dots**
G. Buchs, D. Bercioux, L. Mayrhofer, O. Gröning
 Carbon 124, 123 (2018)