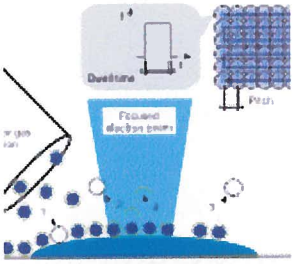
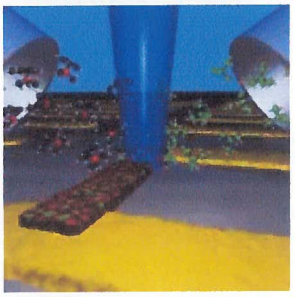
FEBIP 2014

GOETHE UNIVERSITÄT FRANKFURT AM MAIN

View onto entrance area of Physics building where the workshop will take place.





Introduction

We are pleased to announce the 5th workshop on Focused Electron Beam Induced Processing FEBIP2014 to be held in Frankfurt am Main, Germany, from July 22nd to 24th 2014. Following the previous successful workshops in Delft (The Netherlands), Thun (Switzerland), Albany (USA) and Zaragoza (Spain) the workshop in 2014 will broaden its scope and include general aspects of electron-controlled chemical lithography.

The workshop will be hosted by the Physics Department of the Goethe University, Frankfurt am Main, which is located on the newly developed Campus Riedberg. On this campus a vibrant and scientifically inspiring atmosphere is generated as it brings together all natural sciences (Physics, Geological Sciences, Chemistry, Biochemistry, Biological Sciences) together with the Max-Planck Institutes for Biophysics and Brain Research, as well as the Frankfurt Institute for Advanced Sciences (FIAS).

The FEBIP2014 takes place in the year of the 100th anniversary of the Goethe University which was founded following an initiative of the citizens of Frankfurt.

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DAY 1	TUESDAY, JULY 22
14:30 - 15:00 (invited)	**Todd Hastings** (University of Kentucky, Electrical and Computer Engineering, Lexington, USA) *Focused Electron Beam Induced Processing with Liquid Reactants using In-situ Hydration and Direct Liquid Injection*
15:00 - 15:15	**Jonas Warneke** (University of Bremen, Institute of Applied and Physical Chemistry, Germany) *Acetone and the Precursor Ligand Acetylacetone: Alike or not in Electron Beam Induced Reactions?*
15:15 - 15:30	**Paul Alkemade** (Kavli Institute of Nanoscience, Delft University of Technology, Delft, The Netherlands) *Deriving precursor decomposition characteristics from He-ion beam induced deposition experiments*
15:30 - 16:00	Coffee break
	FEBIP modeling (chair: tba)
16:00 - 16:30 (invited)	**Roser Valentí** (Institute for Theoretical Physics, Goethe University, Frankfurt am Main, Germany) *Simulating the FEBID Process via Ab-initio Techniques*
16:30 - 16:50	**Andrey Solov'yov** (MBN Research Center, FIZ, Frankfurt am Main, Germany) *MBN Explorer - a Powerful, Universal Tool for Simulating Multiscale Complex Molecular Structure and Dynamics: Possible Applications for FEBIP*
16:50 - 17:10	**Ivo Utke** (Empa, Laboratory for Mechanics of Materials and Nanostructures, Thun, Switzerland) *Determination of the surface kinetics parameters from a series of spot exposures with Pulsed Focused-Electron-Beam-Induced-Deposition*
17:10 - 17:30	**Heinz Wanzenböck** (Vienna University of Technology, Vienna, Austria) *Insights in precursor flux distribution on the sample surface - Is the nozzle setup really important?*
17:30 - 20:00	Poster session I with pretzel & beer

Insights in precursor flux distribution on the sample surface - Is the nozzle setup really important?

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The precursor supply is a fundament of focused electron beam induced deposition (FEBID) but few studies exist on the actual gas impinging rates on the sample surface. With most FEBID experiments the precursor supply is achieved by gas injection systems (GIS) based on a microtube injector nozzle. With such a nozzle geometry local distribution of precursor gas impinging on the sample surface influences the local precursor coverage, which is decisive for FEBID. This study investigates the surface flux distribution of the gas injected through a GIS nozzle.

Several studies have tried to deduct the local gas impinging rates from the deposited volume or height of the FEBID material [1-3]; however, this measurement category is not accurate as it is also influenced by the surface diffusion of the precursor and the precursor-specific deposition yield. Therefore, we have chosen a purely experimental way to directly measure the distribution of nozzle-borne gas molecules impinging on a virtual surface plane.

We used a self-constructed gas-injection systems (GIS) is equipped with tube based injection nozzles of 10 mm length and 350 µm inner diameter. For measurement of the injected gas a collection nozzle was mounted to the sample stage and connected to a residual gas analyzer (RGA) mounted to the process chamber. The RGA signal was calibrated to measure an absolute gas flow, so that a quantitative measurement became possible. For gas flux distribution on the sample surface the collection nozzle moved in x-y direction along the surface plane and, thus, allowed for mapping and quantification of the local gas flux.

For the gas flux distribution on the sample surface an argon flow in the range from $4x10^{+12}$ atoms/s to $4x10^{+16}$ atoms/s (0.088 sccm) was injected through the GIS-nozzle. On the sample surface the gas distribution strongly depends on the distance of the deposition area to the nozzle exit. A change of the nozzle alignment by only 300µm could result in a change of the precursor impinging rate of 50%. The experimental results were also compared to a simulation of the gas flux distribution using software by Friedli and Utke [3]. Similarities and differences will be discussed in this presentation.

In a next step the same GIS setup was used for deposition of iron on 5x5 µm² areas utilizing the precursor iron pentacarbonyl. A set of 42 deposits was fabricated at different positions with regard to the injection nozzle. AFM measurements of the deposits again revealed a position dependent difference in the deposited volume. However, neither the volume nor the profile shape of deposition correlated with the simulated gas impinging rates. This proves that - as expected - not 100% of the available precursor quantitatively decomposes, so that the resulting deposition heights are not proportional to the simulated gas impinging rate. We will demonstrated that at low gas impinging rates the deposition rate is strongly affected by precursor diffusion on the sample surface and will present the diffusion coefficient of the iron pentacarbonyl precursor during the deposition experiment.

References

[1] K. Furuya, M. Shimojo, M. Takeguchi, M. Song, K. Mitsuishi, M Tanaka,"*Position controlled fabrication of metal nanostructures with focused electron beam*", TMS Annual Meeting 2008 1,105 (2008)

[2] R. Winkler, J. Fowlkes, A. Szkudlarek, I. Utke, P.D. Rack, H. Plank, "*The Nanoscale Implications of a Molecular Gas Beam during Electron Beam Induced Deposition*", ACS Appl. Mater. Interfaces, 2014, 6 (4), 2987

[3] V. Friedli and I. Utke, "*Optimized molecule supply from nozzle-based gas injection systems for focused electron- and ion-beam induced deposition and etching: simulation and experiment*" J. Phys. D: Appl. Phys. 42 (2009) 125305, doi:10.1088/0022-3727/42/12/125305

[4] Homepage of EMPA, Thun (CH); http://www.empa.ch/plugin/template/empa/1091/*/---/l=1