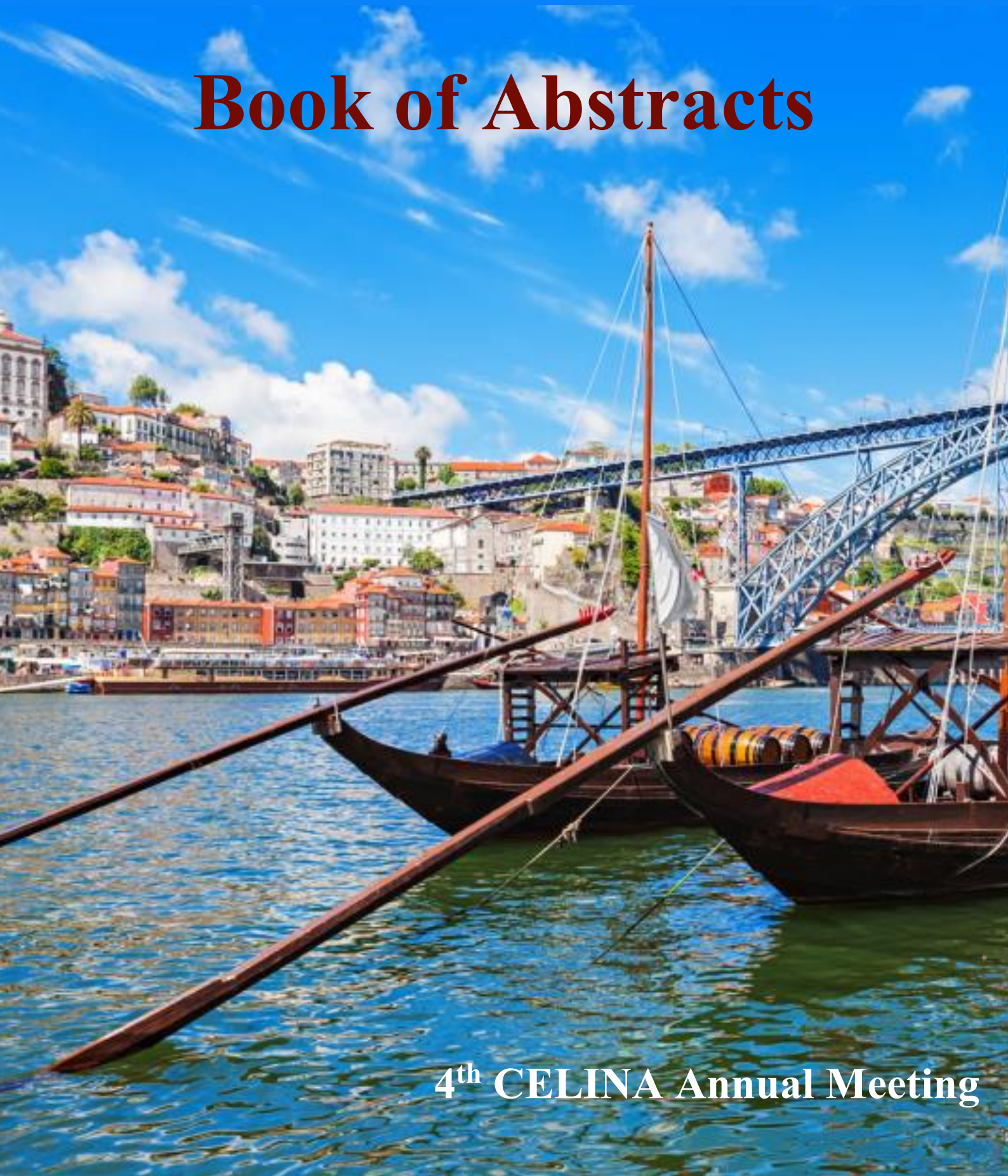
CELINA 2017

cost
EUROPEAN COOPERATION
IN SCIENCE AND TECHNOLOGY

Chemistry for ELectron-Induced NAnofabrication (CELINA)
COST Action CM1301

Porto 13-16 September 2017

Book of Abstracts



4th CELINA Annual Meeting

SCIENTIFIC PROGRAMME OF THE 4th CELINA 2017 annual meeting

Wednesday 13th September

14:00 – 19:00 REGISTRATION AND WELCOME RECEPTION (Seminário de Vilar, Porto)

Thursday 14th September

08:30 – 09:00 **Opening Remarks**

09:00 – 09:20 **CELINA overview and synthetic perspectives**
Chair: Kees Hagen
Petra Swidereck (*University of Bremen*)
"COST Action CM1301 – CELINA: What has been achieved and what lies ahead?"

09:20 – 09:50 **Novel developments in FEBID and beyond**
José Maria de Teresa (*University of Saragoza)*
"Novel developments in FEBID for magnetic materials"

09:50 – 10:20 **Armin Gölzhäuser** (*University of Bielefeld*)
"Imaging, modification and analysis of nanostructures with the helium ion microscope"

10:20 – 10:40 **Teodor Gotszalk** (*Wrocław University of Technology)*
"Novel devices including functional FEBID structures"

10:40 – 11:10 COFFEE BREAK

11:10 – 11:40 **Carboxylate precursors**
Chair Heinrich Lang
Iwona Szymanska (*Nicolaus Copernicus University in Toruń*)
"Overview of properties and synthetic strategies towards carboxylate FEBID precursors"

11:40 – 12:00 **Ivo Utke** (*EMPA – Swiss Federal Laboratories for Material Science and Technology)*
"Gas assisted focused electron beam induced deposition with low volatility precursors"

12:00 – 12:20 **Katarzyna Madajska** (*Nicolaus Copernicus University in Toruń*)
"Perfluorinated silver (I) carboxylate compounds for focused electron beam induced deposition (FEBID)"

12:20 – 12:50 **Lionel Amiaud** (*University of Paris-Sud*)
"New FEBID copper precursor under high vacuum for the study of chemical processes induced by low energy electron irradiation"

12:50 – 14:00 LUNCH

Bimetalic precursors

14:00 – 14:30 Chair: Nigel Mason

Sven Barth (*Technical University of Vienna)*
"Synthesis of heteroleptic and metallic precursors for focused electron beam induced deposition"

14:30 – 15:00 **Oddur Ingólfsson** (*University of Iceland*)
"Electron induced fragmentation of bimetallic focused electron beam induced deposition precursors"

15:00 – 15:30 **Michael Huth** (*Goethe University)*
"Complex 3D magnetic nanostructures prepared by FEBID"

15:30 – 15:50 **Ragesh Kumar** (*University of Iceland*)
"Electron induced surface reaction of bimetal FEBID precursor molecules $HFeCo_3(CO)_{12}$ and $H_2FeRu_3(CO)_{13}$"

15:50 – 19:00 Poster Session
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Friday 15th September

Neutral excitation and dissociation

09:00 – 09:30 Chair: Oddur Ingólfsson
Juray Fedor (*Czech Academy of Sciences*)
"Neutral dissociation: review of experimental approaches"

09:30 – 10:00 **Matija Zlatar** (*University of Belgrade)*
"The role of electronic excitations in FEBID precursors"

10:00 – 10:20 **Juraj Orzsagh** (*Comenius University*)
"Electron induced fluorescence – detection of neutral fragments"

10:20 – 10:40 **Anita Ribar** (*Comenius University and University of Innsbruck*)
"The role of electron self-scavenging in aggregates of $Cr(CO)_6$"

10:40 – 11:10 COFFEE BREAK

11:00 – 11:40 **Novel developments in FEBID and beyond**
Chair: Armin Gölzhäuser
Gregor Hlawaczek (*Institute for Ion Beam Physics and Materials Research)*
"Nano-fabrication with the helium microscope"

11:40 – 12:10 **CELINA overview and synthetic perspectives**
Lisa McElwee-White (*University of Florida)*
"Mechanism-based design of precursors for FEBID"

12:10 – 12:50 Discussion on future activities
COST Action CM1301 CELINA WG Meetings

12:50 – 14:00 **LUNCH**
14:00 – 19:00 **Walking tour**
19:00 **CONFERENCE DINNER**

Saturday 16th September

09:00 – 09:30
Process gases for deposit purification and lithography
Chair: Ivo Utke
Mostafa M. Shawarav (*Institute of solid state electronics*)
"An overview of in-situ ad ex-situ purification strategies for FEBID gold nanostructures"

09:30 – 10:00 **Anpan Han** (*Technical University of Denmark)*
"Organic ices resists"

10:00 – 10:20 **Markus Rohdenburg** (*University of Bremen*)
"Expanding and understanding water-assisted purification procedures: a case study of the potential FEBID precursor $(EtCp)_2Ru$"

10:20 – 10:40 **Carboxylate precursors**
Katja Höflich (*EMPA – Swiss Federal Laboratories for Material Science and Technology*)
"Direct electron beam writing of silver-based nanostructures"

10:40 – 11:10 **COFFEE BREAK**

11:10 – 11:30
Improved control over electron-driven processing
Chair: Juraj Fedor
Janina Kopyra (*Siedlce University)*
"Low energy electron triggered fragmentation of metal acetylacetonates"

11:30 – 11:50 **Neutral excitation and dissociation**
Sylwia Ptasinska (*University of Notre Dame*)
"Instrumentation for neutral radical detection from gas-phase molecular dissociative electron attachment"

11:50 – 12:10 **Improved control over electron-driven processing**
Gian Carlo Gazzadi (*S3 center – Nanoscience Institute)*
"FEBID of W and Pt precursors at very low energy"

12:10 – 12:30 **Sascha Koch** (*University of Bielefeld)*
"Amplified cross-linking efficiency of SAMs through targeted DEA for production of CNMs"

12:30 – 12:50 **Concluding remarks**
12:50 – 14:00 **LUNCH**
14:00 **Departure**

T-09: Synthesis of heteroleptic and -metallic precursors for focused electron beam induced deposition

Sven Barth[1], Lukas Hrachowina[1], Fabrizio Porrati[2], Marc Hanefeld[2], Paul Weirich[2], Michael Huth[2], Ragesh Kumar T.P.[3], Ragnar Bjornsson[3], and Oddur Ingolfsson[3]

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Homometallic carbonyls are widely used precursors for nanomaterial synthesis in gas phase processes and in liquids to form metallic coatings or nanostructures. Many of these carbonyls are commercially available and therefore they have been extensively studied. In particular, the deposition of metallic nanostructures by focused electron beam deposition (FEBID) using these homometallic carbonyls has been investigated and optimized in the recent past.[1, 2] In order to circumvent the use of multiple gas sources for the deposition of bimetallic nanostructures hetero-metallic carbonyls have been prepared.

As a proof of concept, $HFeCo_3(CO)_{12}$, $DFeCo_3(CO)_{12}$ and $H_2FeRu_3(CO)_{13}$ have been prepared and structurally compared.[3, 4] The heterometallic carbonyl clusters exhibit low vapor pressure; however, the compounds are volatile enough for the use in FEBID experiments. Despite the similarities in the cluster cores and also in the calculated energy levels, FEBID deposits differ significantly. $HFeCo_3(CO)_{12}$ results in deposits with high metal content (> 80%) while the deposited material using $H_2FeRu_3(CO)_{13}$ contains significantly lower metal content. Structural and chemical similarities as well as differences can help to understand the decomposition behaviour of these molecular precursors.[5]

In order to extend this approach of predefinition of deposit composition via precursor species, a compound containing metal and metalloid has been prepared. The $Mn(CO)_5(SiH_3)$ precursor has been prepared by modified synthesis procedures but similar intermediates described in literature. In contrast to the termetallic precursors described *vide supra*, this precursor is highly volatile at room temperature due to low molecular mass and very limited intramolecular interactions. First results on deposit formation in the FEBIP process and deposit characterisation will be discussed.

This work was conducted within the framework of the COST Action CM1301 (CELINA).

References

[1] L. Serrano-Ramon, R. Córdoba, L. A. Rodríguez, C. Magén, E. Snoeck, C. Gatel, I. Serrano, M. Ricardo Ibarra, J. M. De Teresa, *ACS Nano* **5** (2011), 7781.
[2] F. Porrati, R. Sachser,M.M. Walz, F. Vollnhals, H. P. Steinrück, H. Marbach, M. Huth, *J. Phys. D* **44** (2011), 425001
[3] F. Porrati, M. Pohlit, J. Müller, S. Barth, F. Biegger, C. Gspan, H. Plank, M. Huth, *Nanotechnology* **26** (2015), 475701.
[4] R. K. T P, P. Weirich, L. Hrachowina, M. Hanefeld, R. Bjornsson, H. R. Hrodmarsson, S. Barth, D. H. Fairbrother, M. Huth, and O. Ingolfsson *Beilstein J. Nanotechn*. submitted.
[5] R. K. T P, S. Barth, R. Bjornsson, O. Ingolfsson *Eur. Phys. J. D* **70** (**2016**), 163.