FOCUSSING ENERGY REALIZING VISIONS

EWPAA 2017

European Workshop on Photocathodes for Particle Accelerator Applications

20-22 September 2017, Berlin-Adlershof, BESSY II

Book of Abstracts

Helmholtz-Zentrum Berlin

für Materialien und Energie GmbH

Wilhelm-Conrad-Röntgen-Campus

BESSY II

Albert-Einstein-Str. 15
12489 Berlin

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Wednesday, 20 September 2017	
13:00 - 14:00	Registration
14:00 - 14:30	**WELCOME (Andreas Jankowiak, *HZB*)**
14:30 - 15:30	**SESSION 1 - GENERAL (Chair: Thorsten Kamps, *HZB*)**
14:30 - 15:00	**An active high QE photocathode** Harry van der Graaf (*NIKHEF)*
15:00 - 15:30	**Experience with photocathode R&D on Cs_2Te for FEL accelerator applications** Daniele Sertore (*INFN Lasa)*
15:30 - 16:00	Coffee Break
16:00 - 18:00	**SESSION 2 - ACCELERATOR APPLICATIONS (Chair: Romain Ganter, PSI)**
16:00 - 16:30	**High brightness polarized electron beams** Kurt Aulenbacher (*Helmholtz-Institut Mainz*)
16:30 - 17:00	**Challenges of the Cs_2Te photocathodes for FLASH and European XFEL** S. Lederer (*DESY*)
17:00 - 17:30	**Operational Aspects of Photocathodes for SRF Guns** Jochen Teichert (*HZDR*)
17:30 - 18:00	**Panel Discussion Accelerator Appplication**
18:00 - 20:00	**SESSION 3 - WELCOME RECEPTION & POSTER SESSION** With beer from Hops & Barley

Thursday, 21 September 2017

09:00 - 10:30	**SESSION 4 - APPLICATION & TECHNOLOGY (Chair: Christoph Hessler, CERN)**
09:00 - 09:30	**Photocathode design using condensed matter methods** Linda Spentzouris *(IIT)*
09:30 - 10:00	**Space charge dominated photoemission at PITZ** M. Krasilnikov (*DESY*)
10:00 - 10:30	**Photocathode Drive Laser Development** Ingo Will (*MBI*)
10:30 - 11:00	Coffee Break
11:00 - 12:30	**SESSION 5 - METALS (Chair: Martin Schmeißer, HZB)**
11:00 - 11:30	**Nano(n)-machining, surface analysis and characterization measurements of a copper photocathode at SPARCLAB** Jessica Scifo (*INFN)*
11:30 - 12:00	**Results on copper photocathodes at Fermi of Elettra and recent results concerning the testing of yttrium photocathode with the cathode test facility** Mauro Trovò (*INFN*)
12:00 - 12:30	**Transverse energy spread measurements on Cu and Mo samples** Lee Jones (*ASTEC Daresbury Lab*)
12:30 - 13:30	Lunch Break

13:30 – 15:30	**SESSION 6 - SEMICONDUCTOR PHOTOCATHODES (Chair: Julius Kühn, HZB)**
13:30 - 14:00	**Photoemission research at Cornell University: recent advances and future perspective** Luca Cultrera (*Cornell University*)
14:00 – 14:30	**The Semiconductor Photocathode R&D for the KEK SRF-Gun** Taro Konomi (*KEK*)
14:30 - 15:00	**GaN Photocatodes R&D** M. Schumacher (*University Siegen*)
15:00 – 15:30	**Panel Discussion Photocatodes**
15:30 - 16:00	Coffee Break
16:00 – 18:00	**SESSION 7 - CAMPUS TOUR: Photocathode Lab, GunLab, berlinPro**
19:00 - 22:00	Dinner at Krokodil (Berlin-Köpenick)

Friday, 22 September 2017	
09:00 - 10:30	**SESSION 8 - THEORY (Chair: Tim Noakes, Daresbury Lab)**
09:00 - 09:30	**Quantum efficiency improvement of metal photocathodes** Victor Chang (*Imperial College London*)
09:30 - 10:00	**Predicting and understanding electronic and optical excitations of realistic materials from ab initio many-body theory** Caterina Cocchi (*Humboldt-University Berlin*)
10:00 - 10:30	**Panel Discussion Theory**
10:30 - 11:00	Coffee Break
11:00 - 12:30	**SESSION 9 - ANALYTICS (Chair: Rong Xiang, HZDR)**
11:00 - 11:30	**Surface chemical and photophysical analysis of alkali antimonide photocathodes** Martin Schmeißer (*HZB)*
11:30 - 12:00	**Spectral Instrinsic Emittance Measurements of Mo(001) and PbTe(111) Photocathodes** Andreas Schroeder (*Univeristy of Illinois at Chicago)*
12:00 - 12:30	**X-ray characterization of alkali antimonide cathode growth** John Smedley *(BNL)*
12:30 - 13:00	**The End - Workshop summary w/ Poster Prize, Announcement for next workshop 2019 and vote for new Workshop name**

Abstracts of Oral Presentations

An active high QE photocathode

Harry van der Graaf[1]

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With new available technology, a much higher QE than 0.4 may be within reach: 1) the absorption/conversion layer could be sandwiched by two single layers of i.e. graphene: by applying a potential difference between these layers, a drift field could push electrons in the conduction band towards the emission side of the layer; 2) With Atomic Layer Deposition (ALD), the conversion layer could, in principle, take the form of a stack of individual ALD layers, combining, for instance, a multiple of alkali and -oxide monolayers; 3) With available ab initio routines like the Vienna Ab initio Simulation Package VASP, electron density, energy distributions and work functions can be calculated, providing parameters needed for a full simulation of the conversion layer; 4) The electron affinity of the emitting surface can be lowered by adding termination atoms onto the graphene at the emission side; 5) The positive effect of the static extracting field can be maximised.

Experience with photocathode R&D on Cs_2Te for FEL accelerator applications

Daniele Sertore[1]

1 INFN Milano – LASA, Segrate (Mi), Italy

Laser triggered photocathodes are key components of the high brightness electron RF guns for 4th generation light sources. Research on semiconductor photocathodes started at INFN-LASA in the 1990s by studying multialkali antimonied compounds (Cs2Sb, K3Sb, and K2CsSb). These materials show high QE coupled to very high sensitivity to vacuum composition. To overcome this, we moved our R&D activity to Cs2Te, which is sensitive to UV light, but has better resistance to gas contamination. Since then, we have started a dedicated R&D program aimed at developing a reliable photocathode for machine operation. Nowadays, our photocathodes are world widely used: at FLASH and XFEL at DESY Hamburg, PITZ in DESY Zeuthen, LCSLII at SLAC, APEX in LBNL and FAST at FNAL.

During the years we have improved our deposition process to reach very reliable characteristics: final QE typically above 10% with spatial uniformity better than 90%. After preparation in a dedicated UHV chamber, photocathodes are transferred, keeping the extreme vacuum condition, to the operation sites. Since transportation/storage may last from several days to weeks, retaining UHV conditions is a fundamental task to preserve photocathode properties. We have address this technical challenge both improving the UHV cathode handling system and developing new pumping scheme based on NEG pumps.

We present an overview of INFN-LASA R&D and technological activity to allow the operation of Cs2TE photocathodes in modern FEL accelerator.

Challenges of the Cesium Telluride Photocathodes for FLASH and European XFEL

Sven Lederer[1], Siegfried Schreiber[1], Laura Monaco[2], Daniele Sertore[2]

1 Deutsches Elektronen-Synchrotron, Hamburg, Germany
2 INFN Milano - LASA, Segrate (Mi), Italy

Key features of cesium telluride (Cs2Te) photocathodes are high quantum efficiency (QE), ability to release high current density electron bunches, and stability in high electric field environments. The photoinjector of the free-electron laser facility FLASH in operation at DESY (Hamburg, Germany) uses Cs2Te photocathodes successfully for more than a decade. At the European XFEL the same type of cathode has also been used successfully during the commission phase. In this contribution we report on the requirements of photocathodes for FLASH and the European XFEL, the challenges as well as our experience with operating them in high gradient, high duty cycle normal conduction RF-guns.

Photocathode design using condensed matter methods

Linda Spentzouris[1], John Zasadzinski[1], Jeff Terry[1], Mark Warren[1], Daniel Velazquez[2], Zikri Yusof[1], Noah Samuelson[1], Adam Denchfield[1], Zhengrong Lee[1], Wisniewski[3], Power[3], Shao[3], Harkay[3], Gai[3]

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3 ANL Collaborators

Recent results on photocathode studies and development at IIT in collaboration with the AWA group at Argonne Lab are reported. Two approaches have been taken toward reaching higher QE superconducting photocathodes; (1) a superconducting substrate with a thin metal film and (2) a superconducting substrate with a semiconducting thin film. The first approach is taken to exploit the proximity effect whereby a thin film can take on the properties of the underlying superconductor. The second approach is taken to exploit the RF transparency of semiconductors. Measurement results of some properties of the hybrid structures are presented. Also presented are measurement results on a multilayer structure of MgO/Ag/MgO. The emissive properties vary with the thickness of the flanking layers. The role of the interface is being further investigated.

Space charge dominated photoemission at PITZ

Mikhail Krasilnikov[1]

1 Deutsches Elektronen-Synchrotron, Hamburg, Germany

The Photo Injector Test facility at DESY in Zeuthen develops high brightness electron sources for modern FELs. The L-band RF gun with Cs2Te photocathode is operated at 60 MV/m. Experimental optimization of the transverse emittance at PITZ resulted in photo injector parameters corresponding to the space charge dominated photoemission regime. But the experimentally observed saturation of the emission curve (the bunch charge versus laser pulse energy) is weaker than the simulated, assuming a homogenous flattop laser transverse distribution. The discrepancy between simulations and measured excess charge may be attributed to the presence of unintentional decaying halo beyond the core of the otherwise presumed homogenous flattop core. By utilizing core + halo particle distributions based on measured radial laser profiles, ASTRA simulations reproduce the behavior of the measured emission curves for a wide range of RF gun and laser operational parameters within the measurement uncertainties.

nano(n)-machining, surface analysis and characterization measurements of a copper photocathode at SPARCLAB

Jessica Scifo[1], David Alesini[1], Maria Pia Anania[1], Marco Bellaveglia[1], Stefano Bellucci[1], Angelo Biagioni[1], Fabrizio Bisesto[1], Fabio Cardelli[1], Enrica Chiadroni[1], Gemma Costa[1], Domenico Di Giovenale[1], Giampiero Di Pirro[1], Roberto Di Raddo[1], Anna Giribono[1], Massimo Ferrario[1], Federico Micciulla[1], Riccardo Pompili[1], Luca Piersanti[1], Vladimir Shpakov[1], Angelo Stella[1], Villa Fabio[1], Alessandro Cianchi[2], Antonella Lorusso[3], E. De Giorgi[4], Mauro Trovò[5], Andrea Mostacci[6], Daniele Passeri[6]

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3 Università del Salento, Dipartimento di Matematica e Fisica, Italy
4 INFN-Sezione di Lecce, Lecce, Italy
5 Elettra - Sincrotrone Trieste SCpA, Basovizza, Italy
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A RD activity on Cu photocathodes is under development at SPARCLAB to have a complete overview of each stage of the photocathode life and of the photoemission properties of the cathodes for high brightness electron beam photoinjectors.The n-machining process consists in diamond milling, afterwards blown with clean air.This procedure shows a reduction of the roughness of the cathode surface and avoids surface contamination caused by other procedures. We present SEM,EDS and AFM techniques used to analyze the cathode surface, roughness,its chemical composition and morphology.The Cu photocathode analysis, before n-machining,shows the degradation of the photoemission properties caused by breakdowns in the RF gun and the silicon contamination due to the polishing procedure.This cathode after n-machining shows a surface with roughness of fewer nm rms and the absence of silicon contaminants.The intrinsic emittance and quantum efficiency measurements before and after n-machining are presented.

References:
[1] D. Xiang et al., First principle measurements of thermal emittance for copper and magnesium, Proc. of PAC07, Albuquerque, New Mexico, USA
[2] Z. Zhang and C. Tang, Analytical study on emittance growth caused by roughness of a metallic photocathode, PRST-AB 18, 053401 (2015)
[3] E.S. Gadelmawla, M.M. Koura, T.M.A. Maksoud, I.M. Elewa, H.H. Soliman, Roughness parameters, Journal of Materials Processing Technology 123 (2002) 133-145
[4] W.S. Graves, L.F. DiMauro, R. Heese, E.D. Johnson, J. Rose, J. Rudati, T. Shaftan, B. Sheehy, MEASUREMENT OF THERMAL EMITTANCE FOR A COPPER PHOTOCATHODE, Proceedings of the 2001 Particle Accelerator Conference, Chicago
[5] D. H. Dowell, "Electron Emission And Cathode Emittance" in High Brightness Electron Injectors for Light Sources, U.S. Particle Accelerator School, Course Materials, 2010
[6] D. H. Dowell, Sources of Emittance in RF Photocathode Injectors, SLAC National Accelerator Laboratory, Menlo Park, CA 94025, USA

The TESS Facility: Energy spread measurements for Cu and Mo photocathodes of known surface roughness, experimental system upgrades, and planned work on a range of metal photocathodes

L.B. Jones[1], T.S. Beaver[1], S. Mistry[1], T.C.Q. Noakes[1], B.L. Militsyn[1], D.P. Juarez Lopez[2,3], C.P. Welsch[2,3,], H.E. Scheibler[4], A.S. Terekhov[4]

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The brightness of a photoelectron injector is fundamentally limited by the mean longitudinal and transverse energy distributions of the photoelectrons emitted from its photocathode, and is increased significantly if the mean values of these quantities are reduced.

Photocathode surface roughness contributes significantly to the observed longitudinal and transverse energy spread, and also modifies the effective surface work function which directly affects quantum efficiency. Surface roughness therefore plays a key role in determining the overall performance of a photocathode.

The Transverse Energy Spread Spectrometer (TESS) [1] is an experimental facility designed to measure transverse and longitudinal energy distributions, and can be used with III-V semiconductor, alkali antimonide/telluride and metal photocathodes. The TESS has been modified recently to incorporate a high-intensity laser-driven plasma broadband light source, and an improved electron detector

We present the results of preliminary work using the TESS in its original configuration to quantify the effects of photocathode surface roughness on copper and molybdenum photocathodes [2], and an update on work to upgrade the system before the commencement of work to investigate the contribution of surface roughness on a range of metal photocathodes with both single-crystal and polycrystalline faces.

References:
[1] Proc. FEL '13, TUPPS033, 290-293
[2] Proc. IPAC '17, TUPAB111, 1580-1583

Photoemission research at Cornell University: recent advances and future perspective

Luca Cultrera[1]

1 CLASSE - Cornell University, Ithaca, USA

Current activities pursued at Cornell University for the production of electron beams are tailored to a wide range of applications from the high intensity beam required by ERLs to ultimate brightness required by X-FELs and UED experiments. We developed the expertise to grow different types of high QE photocathodes belonging to the alkali antimonide family. Those materials are ideal candidates for high intensity beam with mA range average currents. When operated near threshold at cryogenic temperature in transmission mode they can also generate electron beams to perform ultrafast electron diffraction of bio molecules. We recently expanded our facility with a Mott polarimeter to include the capability to measure polarization of the electron beam. The photocathode lab is being complemented by a dedicated photo-gun laboratory to test the photocathode properties in a real environment and to perform measurement of the beam properties under new and yet unexplored operating conditions.

The Semiconductor Photocathode R&D for the KEK SRF-Gun Project

Taro Konomi[1], Kako Eiji[1], Kobayashi Yukinori[1], Michizono Sinichiro[1], Sakai Hiroshi[1], Umemori Kensei[1], Yamaguchi Seiya[1], Matsuda Ryuichi[2], Yanagisawa Takeshi[2], Yanagisawa Takeshi[3]

1 KEK, Tsukuba, Japan
2 MHI, Takasago, Japan
3 MHI-MS, Kobe, Japan

KEK has been developing a superconducting RF gun for high current CW linac since 2013. The SRF gun is combination of a 1.3 GHz, 1.5-cell superconducting RF cavity and a backside excitation type photocathode. The prototype cavity #1 and the photocathode were developed individually. The maximum surface electric field of the cavity reached 75 MV/m with bulk niobium cathode rod. Next step is the combination of the cavity and photocathode substrate. We have fabricated a new cathode rod which can mount the semiconductor substrate. And we are designing the new SRF gun and deposition chamber for beam operation test. In this presentation, I will report the vertical test results with a new cathode rod and designing the SRF gun #2 for beam test.

Quantum efficiency improvement of metal photocathodes

Victor Chang[1], Nicholas M Harrison[1], Tim Noakes[2], Bruno Camino

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Free electron lasers are the 4th generation of light source for the study of structural and time resolved properties of material and molecular. The quality of the emitted radiation depends on the quality of the electron beam. In this work, an approach to the photoemission of electrons is studied with ab initio calculations and an extension of three steps model. This approach is able to correlate directly the photoemission to the electronic, atomic and chemical structure of the surface. Surface engineering of photocathodes show promising possibilities in the control of their properties. It has previously been demonstrated that thin metal oxide films can generate surface localised states and alter the work function of the surface. A systematic understanding of these interactions is therefore a promising approach to engineering highly efficient photocathodes. Our approach, suggest that metal thin oxide over metal photocathodes can be used to increase the quantum efficiency of materials.

Predicting and understanding electronic and optical excitations of realistic materials from ab initio many-body theory

Caterina Cocchi[1,2]

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2 IRIS Adlershof, Berlin, Germany

The theoretical study of electronic and optical properties of realistic materials requires a suitable formalism that is accurate, insightful, and efficient. Ab initio methods based on DFT and many-body perturbation theory (GW and Bethe-Salpeter equation) are the optimal choice to do so. With crystal structures and atomic species as the only input parameters, they can be used from bulk to nanostructures. Within all-electron implementations [1], excitations from the visible to the deep x-ray region can be described [2]. I will demonstrate the power of these methods with 3 examples involving novel materials like graphene-based heterostructures [3], transparent conducting oxides [4], and hybrid perovskites [5]. Electron correlation is shown to be crucial for an accurate description of band structures and light-matter interaction. Such ab initio many-body approaches, complementary to laboratory experiments, offer unprecedented insight into the physical properties of realistic materials.

References:
[1] A. Gulans, et al., J. Phys.: Condens. Matter 26, 363202 (2014).
[2] C. Vorwerk, C. Cocchi, and C. Draxl Phys. Rev. B 95, 155121 (2017)
[3] W. Aggoune, C. Cocchi, et al., J. Phys. Chem. Lett. 8, 1464 (2017).
[4] C. Cocchi, et al., Phys. Rev. B 94, 075147 (2016).
[5] C. Vorwerk, C. Hartmann, C. Cocchi, M. Baer, et al., preprint.

Surface Chemical and photophysical analysis of alkali antimonide photocathodes

Martin Schmeisser[1], Julius Kühn[1], Thorsten Kamps[1], Luca Cultrera[2], Hyeri Poprocki-Lee[2]

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2 Cornell, Ithaca, NY, USA

We report on surface chemical measurements using XPS which led to the development of the deposition procedure of the CsK2Sb photocathode for bERLinPro using an alkali metal co-evaporation technique. Intrinsic emittance and spectral response measurements on Cs3Sb and CsK2Sb photocathodes will also be discussed.

Spectral Instrinsic Emittance Measurements of Mo(001) and PbTe(111) Photocathodes

W. Andreas Schroeder[1], Gowri Adhikari[1]

1 Univeristy of Illinois at Chicago, USA

Measurements of the spectral dependence of the intrinsic emittance (i.e. rms transverse momentum) of Mo(001) and PbTe(111) single-crystal photocathode faces are presented for 4.2-5.3eV incident UV photon energies. The results for Mo(001) are consistent with density functional theory (DFT) evaluations for a one-step photoemission process from the four involved bulk electronic bands [1] — a spectral dependence on the excess photoemission energy that is ~15% less than that expected from standard expressions [2,3]. For the PbTe(111) photocathode, the results indicate a significant relative reduction in intrinsic emittance (although not as strong as theoretically expected) that is primarily due to the extremely low effective mass of the photo-emitting valence band states which restrict the transverse momentum of the emitted electrons. The novel laser-based tunable ultraviolet radiation source used to obtain the presented data will also be described.

References:

[1] Emission properties of body-centered cubic elemental metal photocathodes,” T. Li, B.L. Rickman, and W.A. Schroeder, J. Appl. Phys. 117 (2015) 134901.
[2] “Quantum efficiency and thermal emittance of metal photocathodes,” D.H. Dowell and J.F. Schmerge, Phys. Rev. Specop. Acc. Beams 12, 074201 (2009).
[3] “Quantum efficiency and transverse momentum from metals,” T. Vecchione, D. Dowell, W. Wan, J. Feng, and H.A. Padmore, paper TUPSO83, Proceedings of FEL 2013, pp.424-426.

Abstracts of Posters

Mg photocathodes and Cs2Te Photocathodes for SRF gun at HZDR

Rong Xiang[1], Andre Arnold[1], Petr Murcek[1], Jochen Teichert[1], Hannes Vennekate[1], Pengnan Lu[1]

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Quality of photocathode is one of the critical issues for the stability and reliability of the photoinjector system. SRF Gun II with Mg photocathode has successfully provided stable electron beams for ELBE users at HZDR. In this work, we present the various cleaning processes (activation) for Mg photocathodes, e.g. high intensity laser cleaning and thermal treatment. Furthermore, we show the first result of the photoemission study on the alternative metallic cathode, for instance MgY alloy. To generate higher bunch charge up to 0.5 nC, Cs2Te photocathode is planned for SRF gun II. Up to now three Cs2Te photocathodes have been used in SRF gun II, however, they showed abnormal phenomena and induced unwanted contamination for the superconducting cavity.

GaN-based Photocathodes for High Brightness Electron Beams

Marc Schumacher[1],Michael Vogel[1], Xiang Jiang[1]

1 Institute of Materials Engineering, University Siegen, Siegen, Germany

Prospective light sources require photocathodes with high quantum efficiency and long lifetime. One promising candidate meeting the aforementioned specifications is gallium nitride (GaN). Due to its wide band gap (Eg = 3,4 eV), GaN can be excited by UV-light sources. Its thermal and chemical stability are added bonuses. In the framework of the present activity, the synthesis of GaN films by means of RF magnetron sputtering is proposed. In this context, gallium, gallium arsenide (GaAs) and GaN are suitable source material candidates, which are sputtered in a Nitrogen and Argon plasma discharge. The conductivity as well as Eg of the corresponding films can be modified by dopants like magnesium and indium, respectively. To assess and optimize the performance of the photocathode the abovementioned requirements are tested in an in-situ setup. In addition to the project outline, first experimental results of GaN coatings synthesized based on a GaAs source are presented.

Investigation of K_2CsSb cathodes

Victor Bechthold[1], Kurt Aulenbacher[1], Monika Dehn[1]

1 Institute for Nuclear Physics, JGU Mainz, Germany

The interest in multi alkali antimonide photocathodes, e.g. K2CsSb, for future ERL projects like BERlinPRO and MESA has grown in last years. In particular for the case of R.f-sources the investigation of the time response is of great importance. In Mainz we are able to synthesize these kinds of photocathodes und investigate their pulse response at 1 Pikosecond level using a radiofrequency streak method. The experimental set-up also allows to clarify the existence of long tails (>10 ps) in the response at a level of <10-3 of the maximum intensity after excitation. We present on the one hand the cathode plant which is used for synthesizing the multi alkali antimonide photocathodes and on the other hand measurements showing pulse responses of K2CsSb at 400 nm laser wavelength. Furthermore an analyzing chamber has been installed, which allows investigation of lifetime under laser heating and in-situ measurements of the work function using a Kelvin Probe.

Status of the Photocathode R&D at CERN

Christoph Hessler[1], Eric Chevallay[1], Valentin Fedosseev[1], Florence Friedel[1], Piotr Gach[1]

1 CERN, Geneva, Switzerland

In the past, photocathode R&D at CERN has been performed within the frame of the CLIC project and the CLIC Test Facility 3 (CTF3 [1]) with the aim to develop and study the performance of photocathodes for the CLIC drive beam. After 10 years of operation CTF3 has been shut down end of 2016. At the same time the PHIN photoinjector, previously installed at an offline test stand at CTF3, has been dismantled and reinstalled at the Advanced Wakefield Experiment (AWAKE [2]). The former CTF3 probe beam accelerator CALIFES, equipped with an operational photoinjector, is currently being transformed to the CLEAR user facility (CERN Linear Electron Accelerator for Research [3]). Within the scope of these changes the photocathode R&D has to be realigned. This poster will present these recent changes in detail, the photocathode R&D status and plans and recent improvements of the photocathode preparation system.

References:
[1] R. Corsini, Final Results from the CLIC Test Facility (CTF3), Proc. IPAC17, Copenhagen, Denmark (2017) p. 1269.
[2] E. Gschwendtner et al., AWAKE, the advanced proton driven plasma wakefield experiment at CERN, Nucl. Instrum. Meth. A 829 (2016) 76.
[3] http://clear.web.cern.ch

Status of the Development of Yttrium Photocathodes for REGAE

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The operation of REGAE (Relativistic Electron Gun for Atomic Exploration) relies on ultra-low emittance at ultra-low bunch charges. To achieve the required low emittance the beam size during emission has to be below 0.1 mm which cannot be achieved with the installed laser system and its boundary conditions. Therefore the aim is to go for small spot size photocathodes. In the past trials with Pt/Au, Au/Mo and Pt/Mo cathodes were not successful. Our attempt is to go for an Yttrium photocathode on a Molybdenum plug. Since Y has a work function of only 3.1 eV, electron emission is possible by usage of green lasers, prohibiting emission from Mo. Therefore a small Y spot would yield an electron beam of the same transversal size. We present results of the first Y/Mo cathodes prepared by laser ablation deposition technique. Measurements of chemical composition as well as surface characterizations will be shown.

GaAs-based cryogenic photoelectron gun for high current applications

Neeraj Kurichiyanil[1], Tobias Eggert[1], Joachim Enders[1], Markus Wagner[1], Simon Weih[1], Yuliya Fritzsche[1]

1 Institut für Kernphysik, Darmstadt, Germany

A dedicated setup for GaAs-based photocathode activation, test, and cleaning with atomic hydrogen ("Photo-CATCH") has been commissioned at the Institut für Kernphysik of TU Darmstadt for photocathode research and the support of the operations of the superconducting Darmstadt electron linear accelerator S-DALINAC. First results from photocathode activation studies indicate that a combination of Cs and Li with oxygen may significantly increase the dark lifetimes of NEA photocathodes while maximum quantum efficiency is obtained from two-step activation processes. To further increase the operational lifetime, a design of an electron gun with cryogenic cathode that significantly reduces ion back bombardment is conceptualized. Simulation results in terms of electron optics and vacuum conditions for this design are presented.

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List of Participants

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	Victor	Chang	Imperial College London
Dr.	Ye	Chen	Deutsches Elektronen-Synchrotron (DESY)
Prof. Dr.	Caterina	Cocchi	Humboldt-Universität zu Berlin
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We are researching new energy materials that will convert and store energy more efficiently and with a smaller ecological footprint than ever before, for example solar cells, thermoelectrics and solar fuels. The photon source BESSY II is an ideal place for studying thin film systems and our CoreLabs an excellent place for producing and analysing them. We make these infrastructures available to researchers from everywhere in the world. Industrial companies are also very welcome. Our internationality, creativity and pursuit of new solutions are what set us apart.

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