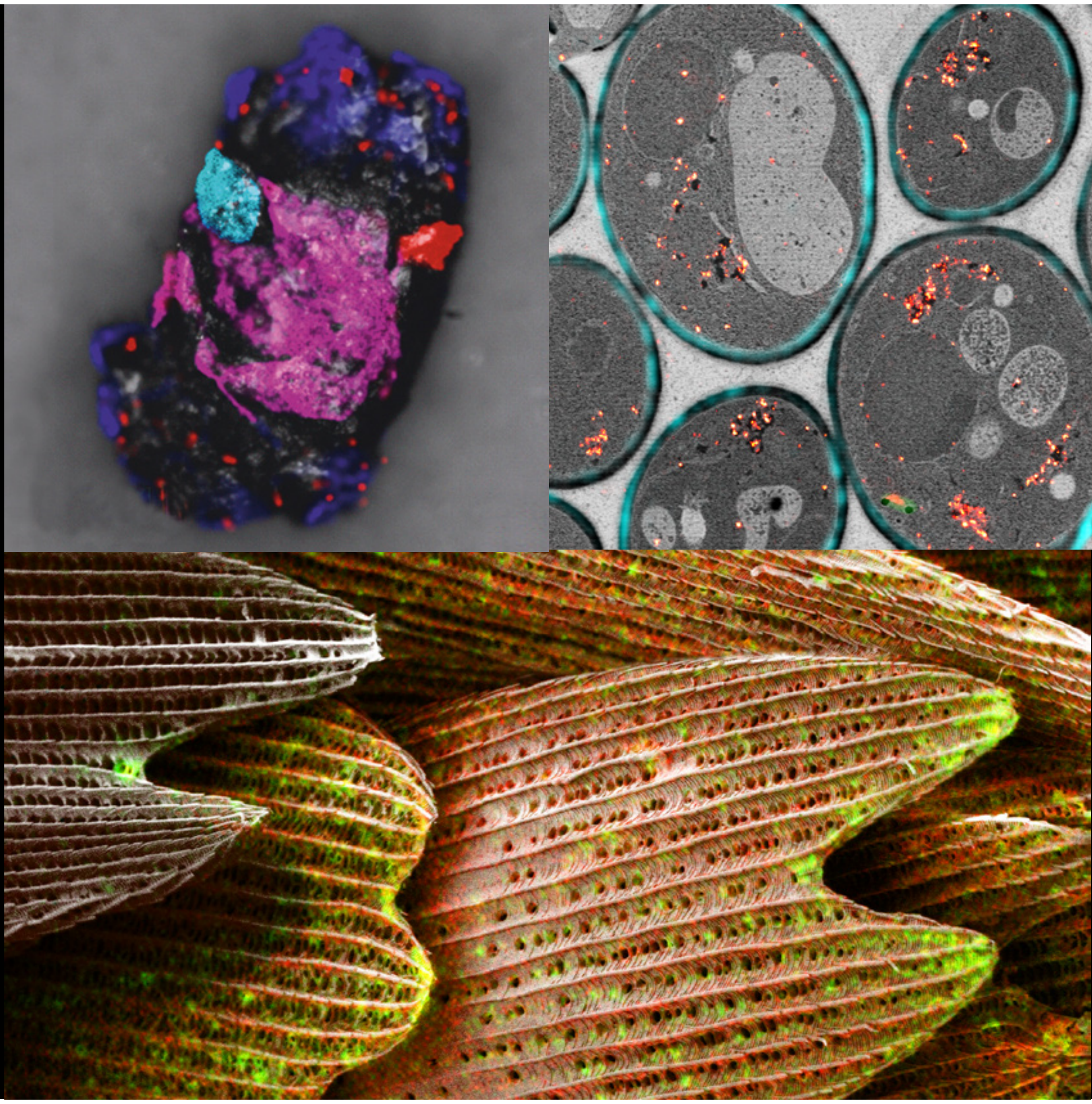
Application Note



# ZEISS Correlative Microscopy Solutions

A Publication Reference List

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## A Publication Reference List

Authors: Dr. Renée Dalrymple, Dr. Eric Hummel,
Tobias Volkenandt
*Carl Zeiss Microscopy GmbH, Jena, Germany*

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**Introduction**

The ability to combine information gathered using different imaging modalities through correlative microscopy has opened doors for new scientific discoveries and improved productivity of sample investigations. One of the largest challenges in these types of experiments is the time and effort involved in relocating the same area of the sample in successive instruments. Commercial solutions from ZEISS provide streamlined workflows and ensure quick and easy sample relocation to facilitate access to these multi-modal types of information. These solutions include Shuttle & Find and ZEN Correlative Array Tomography software modules as well as the use of ZEISS Atlas 5.

The Shuttle & Find software module for ZEN provides a quick and easy workflow for collecting and combining data from your ZEISS light and electron microscopes. Sample relocation is performed through the use of fiducial markers to calibrate the coordinates of the stage position between instruments. This can be accomplished through the use of special sample holders with embedded fiducials, coverslips with fiducial markers printed on them, or even defining your own sample holder. A quick three fiducial calibration on each instrument allows images to be acquired all over the sample and then relocated on the next system with the click of a button and removable fiducial markers allow for additional sample preparation steps in-between imaging modalities for uncompromised imaging with each technique.

For three dimensional correlative microscopy, ZEN Correlative Array Tomography (CAT) guides you through the complete workflow of detecting serial sections, imaging, and reconstructing the data from the light and electron microscope. Intuitive software wizards walk you through automatic recognition of serial sections and transfer of a user defined region of interest to all identified sections. Images of these regions are automatically acquired and then aligned in order to obtain a three dimensional image with z-resolution corresponding to the thickness of the sections. This technique can be used not only to obtain three dimensional light microscopy images with high z-resolution, but also to correlate them to SEM images for 3D correlative microscopy.

ZEISS Atlas 5 provides high end, software to automatically drive the SEM instruments as well as correlate images from multiple sources. Relocation of sample areas between microscopes can be accomplished via overview images or fiducial calibrations with Shuttle & Find. Efficiency of FIB-SEM imaging is also improved through the ability to precisely target sub-surface sites via correlation with light or X-ray data. It also provides the ability to automatically acquire array tomography data for 3D imaging [1].

This reference list compiles a collection of papers that have utilized, provided protocols, or reviewed correlative microscopy approaches. These examples of expanding the understanding of samples through correlative microscopy bridge a multitude of techniques including light (brightfield, widefield fluorescence, confocal, and superresolution), electron (SEM, FE-SEM, FIB-SEM, TEM), and X-ray microscopy in both life science and materials applications.

## Life Science

| Publication | Journal | Sample | Application | System | Sample relocation method | Alignment of images from different methods | z-stack alignment |
|---|---|---|---|---|---|---|---|
| Blazquez-Llorca L , Hummel E., Zimmermann H,. Zou C , Burgold S, J. Rietdorf, J. Herms (2015). Correlation of two-photon in vivo imaging and FIB/SEM microscopy Journal of Microscopy, 259, 129 – 136. | Journal of Microscopy | Upper cortex mouse brain | In vivo correlative imaging | Multiphoton, FIB-SEM | S&F | ImageJ | ImageJ TomoJ |
| Cosenza, M. R., et al., 2017, Cell Reports 20, 1906 – 1920 August 22, 2017, doi:10.1016/j.celrep.2017.08.005 | | | | ZEISS Axio Observer.Z1, ZEISS Auriga 60 with Atlas 3D | Mattek dishes with coordinate system | TrakEM2 plugin of FIJI | |
| Markert, S. M., et al., 3D subcellular localization with superresolution array tomography on ultrathin sections of various species, Methods in Cell Biology, Volume 140, ISSN 0091679X, doi:10.1016/bs.mcb.2017.03.004 | | Ultrathin sections of Caenorhabditis elegans, Trypanosoma brucei, and brain tissue of Cataglyphis fortis and Apis mellifera | Superresoution array tomography | ZEISS Elyra S.1, ZEISS Crossbeam 540, JEOL JSM-7500F, TESCAN XEIA3 | Manually, imaged entire area of serial sections | Manually with Inkscape | IMOD or Fiji and AMIRA |
| Caplan, J., et al., Correlative Protein Localization in Yeast High-Resolution Localization of Fluorescent Proteins Using Shuttle & Find for Superresolution and Scanning Electron Microscopy. ZEISS White Paper, May 2013. | | Yeast (Saccharomyces cerevisiae), G-Protein coupled receptors | Correlative super-resolution and SEM imaging | ZEISS Elyra PS.1 (dSTORM and SIM), ZEISS Auriga 60 | ZEISS Shuttle & Find with fiducial ITO-coverslips | | |
| Kharkwal H, Smith CG, Wilson DW. 2016. Herpes simplex virus capsid localization to ESCRT-VPS4 complexes in the presence and absence of the largetegument protein UL36p. J Virol 90:7257–7267. doi:10.1128/JVI.00857-16 | | HEK293 cells | Correlative light and electron microscopic analysis of HSV capsid/ Vps4-EQ-GFP colocalization | ZEISS Axio Observer, ZEISS Supra 40 SEM | ZEISS Shuttle & Find | ZEISS Axio-Vision software | |
| Hohn, K., et al., Preservation of protein fluorescence in embedded human dendritic cells for targeted 3D light and electron microscopy, Journal of Microscopy, Vol. 00, Issue 0 2015, pp. 1 – 8, doi:10.1111/jmi.12230 | | HIV-pulsed mature human dendritic cells | Localizing subcellular structures of interest in plastic embedded samples | ZEISS LSM 710, ZEISS Crossbeam Neon 40 | Imprinted coordinate system, custom built plug-in for the LSM software | Reference marks at the interface were easily imaged in the confocal reflection mode | ImageJ |
| Tharkeshwar, A. K., et al., A novel approach to analyze lysosomal dysfunctions through subcellular proteomics and lipidomics: the case of NPC1 deficiency, Scientific Reports, 7:41408, doi:10.1038/srep41408 | | NPC1-KO HeLa cells | Correlative SIM and EM (SIM-CLEM) of Superparamagnetic iron oxide nanoparticles (SPIONs) with filipin-positive degradative organelles | ZEISS Elyra S.1, JEOL JEM-1400 | Marks on bottom of MatTek dishes | Overlaid using morphological signatures using GIMP software | |
| Thomas, C., et al., Functional and Structural Investigation of Songbird Brain Projection Neurons withShuttle & Find Correlative Microscopy in Life Sciences, ZEISS White Paper, July 2010 | | Zebra finch brain sections | CLEM to identify and investigate the ultrastructure of cells | ZEISS Axio Observer.Z1, ZEISS Supra 40VP SEM | ZEISS Shuttle & Find | | |
| Thomas, C., et al., Multiscale Analysis of Bacteria Population in Legume Root Nodules with Shuttle & Find, ZEISS White Paper, July 2010 | | Root nodules of a mung bean plant (Vigna radiata), inoculated with the rhizobia Bradyrhizobium japonicum | CLEM of root nodules and rhizobia bacteria | ZEISS Axio Imager.M1, ZEISS Gemini 1530 | ZEISS Shuttle & Find | | |

## Life Science

| Publication | Journal | Sample | Application | System | Sample relocation method | Alignment of images from different methods | z-stack alignment |
|---|---|---|---|---|---|---|---|
| Hummel, E., et al., Correlation of Two-Photon in Vivo Imaging and FIB-SEM Microscopy, ZEISS White Paper, June 2013 | | Mice expressing GFP under control of Thy-1 promoter (GFP-M line) | CLEM using two-photon imaging and FIB SEM | ZEISS LSM 710 with two-photon excitation, ZEISS Crossbeam Auriga electron microscope | ZEISS Shuttle & Find | Cross-correlation | |
| Schaer, C., A., et al., Mechanisms of haptoglobin protection against hemoglobin peroxidation triggered endothelial damage, Cell Death Differ. 2013 Nov; 20(11): 1569−1579, doi:10.1038/cdd.2013.113 | | Endothelial cells | CLEM of the redistribution of β-catenin and cellular structure | ZEISS Axio Imager.M1, ZEISS Gemini 1530 | ZEISS Shuttle & Find Axio Vision Software 4.8.2 | Adobe Photoshop Software CS3 | |
| Wang, W., et al., CEP162 is an axoneme-recognition protein promoting ciliary transition zone assembly at the cilia base, Nat Cell Biol. 2013 Jun; 15(6): 591−601, doi:10.1038/ncb2739 | | RPE1 cells | CLEM to reveal location of GFP-Cep162 and cilia tip structure | ZEISS Axio Observer, ZEISS Supra 40 | ZEISS Shuttle & Find | ZEISS Axio-Vision v 4.8 | |
| Fitzpatrick, J., A.J., et al., Correlative Light, Electron, and Ion Microscopy for the Study of Urinary Tract Infection Pathogenesis, Microsc. Microanal. 23 (Suppl 1), 2017, doi:10.1017/S1431927617007206 | | Whole bladders infected with GFPoverexpressing E. coli | CLEM to locate intracellular bacterial communities and investigate their ultrastructure | Laser Scanning Confocal microscope, FIB-SEM | ZEISS Shuttle & Find and fiducial ITO-coverslips | alignmnet of extracellular markers | |
| Karanasios et al; Autophagy initiation by ULK complex assembly on ER tubulovesicular regions marked by ATG9 vesicles (2016), Nature Communications 7, 12420; doi:10.1038/ncomms1242 | | Cell culture HEK 293 | CLEM to investigate the early stages of autophagosome formation. | ZEISS Crossbeam 540 Merlin3view Superresolution microscope (Nikon), LSM | Atlas5 for relocalization | Alignment using post-processing software | Volocity Software |
| Kasthuri, N., et al., Saturated Reconstruction of a Volume of Neocortex, Cell 162, 648−661, July 30, 2015, doi:10.1016/j.cell.2015.06.054 | | Brain tissue serial sections | Automated technoogy for reconstruction of sub-volume of mouse neocortex | ZEISS Sigma scanning electron microscope, ZEISS Atlas, ZEISS MultiSEM 505, FEI Magellan thru-the-lens detector | | Matlab | VAST |

## Materials Science

| Publication | Journal | Sample | Application | System | Sample relocation method | Alignment of images from different methods |
|---|---|---|---|---|---|---|
| Shearing, P., Gelb, J. & Brandon, N. Correlative Microscopy in the Laboratory: Analysis of the Triple-Phase Boundary in a Solid-Oxide Fuel Cell Electrode Using X-ray Computed Nanotomography and FIB-SEM. Microscopy and Microanalysis 16, 872–873 (2010). doi:10.1017/S1431927610055674 | Microsc. Microanal. | Ni-YSZ SOFC (solid oxide fuel cell) | Energy Storage FIB-preparation for nano-XRM, FIB-SEM tomography | ZEISS Xradia Ultra, Nvision | | |
| Chen, Y. et al. Direct-methane solid oxide fuel cells with hierarchically porous Ni-based anode deposited with nanocatalyst layer. Nano Energy (2014). doi:10.1016/j.nanoen.2014.08.016 | Nano Energy | Ni-YSZ SOFC (solid oxide fuel cell) | Energy Storage Characterization of SOFCs | ZEISS Xradia Versa, ZEISS Ultra Plus | | |

## Materials Science

| Publication | Journal | Sample | Application | System | Sample relocation method | Alignment of images from different methods |
|---|---|---|---|---|---|---|
| Misak, H. E. & Mall, S. Investigation into microstructure of carbon nanotube multi-yarn. Carbon 72, 321–327 (2014). doi:10.1016/j.carbon.2014.02.012 | Carbon | Carbon nanotube (CNT) yarns | Energy StorageCharacterization of CNT yarns | ZEISS Axio Observer, ZEISS Xradia 520 Versa | | |
| Merkle, A. Automated correlative tomography using XRM and FIB-SEM to span length scales and modalities in 3D materials. (2015). | Microscopy and Analysis | Al 7075 | Metals Correlative Microscopy between XRM and FIB-SEM | ZEISS Xradia 520 Versa, ZEISS Crossbeam 540, ZEISS Atlas | | |
| Sudhanshu S. Singh, Jose J. Loza, Arno P. Merkle, Nikhilesh Chawla Three dimensional microstructural characterization of nanoscaleprecipitates in AA7075-T651 by focused ion beam (FIB) tomography doi:10.1016/j.matchar.2016.05.009 | Materials Characterization | AA7075-T651 | Metals 3D Microstructural charaterization | ZEISS Crossbeam 540, ZEISS Atlas | | |
| Kejzlar, P., et al., Assesment of the structure and high temperature strength of $Fe_{35}Al_5Zr$ intermetallic alloy, Metal 2013, 15. – 17.5.2013, Brno, Czech Republic, EU | Metal | $Fe_{35}Al_5Zr$ alloy | Metals Structure and phase composition of the $Fe_{35}Al_5Zr$ alloy | ZEISS Axio Imager.M2m, ZEISS Ultra Plus | ZEISS Shuttle & Find, correlative microscopy sample holder | |
| Meyer, P. et. Al. In Depth Analyses of LEDs by a Combination of X-ray Computed Tomography (CT) and Light Microscopy (LM) Correlated with Scanning Electron Microscopy (SEM), J. Vis. Exp. (112), e53870, doi:10.3791/53870 (2016). | J. Vis. Exp. | LED | Semiconductor White light LEDs | | | |
| Thomas, C. Correlative Microscopy of Optical Materials, Imaging & Microscopy, Oct. 13, 2014 | Imaging & Microscopy | LED | Semiconductor | | ZEISS Shuttle & Find, correlative microscopy sample holder | |
| Gelb J, Finegan DP, Brett DJL, et al. Multi-scale 3D investigations of a commercial 18650 Li-ion battery with correlative electron and X-ray microscopy. J Power Sources 2017;357:77. doi:10.1016/j.jpowsour.2017.04.102 | J Power Sources | Lithium Ion Batteries | Energy Storage | | | |
| Weisenberger et al., Multi-scale characterization of lithium ion battery cathode material by correlative X-ray and FIB-SEM microscopy, Microscopy and Analysis 29(5): 17–19, September 2015. | Microscopy and Analysis | Lithium Ion Batteries | Energy Storage Cathode material characterization | | | |
| Ch. Thomas et.al. Correlative Light and Electron Microscopy (CLEM) for Characterization of Lithium Ion Battery Materials, Microsc. Microanal. 16 (Suppl 2), 2010, doi:10.1017/S1431927610056254 | Microsc. Microanal. | Lithium Ion Batteries | Energy Storage | | | |
| Merkle AP, Gelb J, Orchowski A, Fuchs J. X-ray microscopy: the cornerstone for correlative characterization methods in materials research and life science. Microsc Microanal 2014; 20 (Suppl 3):986. doi:10.1017/S1431927614006655 | Microsc. Microanal. | Copper-Aluminum Alloy | Metals | | | |
| Gelb, J., Volkenandt, T., & Merkle, A. (2017). Correlative Microscopy in 3D: Recent Advancements in Multi-Scale Materials Science. Microscopy and Microanalysis, 23(S1), 332−333. | Microsc. Microanal. | Carbonfiber reinforced composite; Corroded Mg alloy | | | | |

## Materials Science

| Publication | Journal | Sample | Application | System | Sample relocation method | Alignment of images from different methods |
|---|---|---|---|---|---|---|
| Vaupel, M., and Zimmermann, H., Topography and Refractive Index Measurement of a Sub-µm Transparent Film on an Electronic Chip by Correlation of Scanning Electron and Confocal Microscopy, ZEISS White Paper, August 2014 | ZEISS Microscopy | Mobile phone chip, letter printed as a gold layer on silicon surface. All covered by polymer passivation layer. | Measuring topography and layer thickness of substrates via CLEM | Confocal Microscope, e.g. ZEISS LSM 700 on Axio Imager.Z2m with software ConfoMap 2. Electron Microscope: ZEISS Auriga | ZEISS Shuttle & Find with Corr-Mic Mat sample holder | |
| Vaupel, M., et al., Graphene Characterization by Correlation of Scanning Electron, Atomic Force and Interference Contrast Microscopy, ZEISS White Paper | ZEISS Microscopy | Stack of graphene layers on silicon wafer with native (2 nm) $SiO_2$ | Localize and measure height variations in graphene layers | ZEISS Axio Imager.Z2m, ZEISS Merlin Compact with AFM | ZEISS Shuttle & Find with Corr-Mic Mat sample holder | |
| Thomas, C., et al., Fast Structural and Compositional Analysis of Aged LiIon Batteries with Shuttle & Find, ZEISS White Paper, Jan 2011 | ZEISS Microscopy | Li-ion batteries | Microstructure characterization of Li-ion batteries with CLEM | ZEISS Axio Imager. Z2, ZEISS Supra 40 VP FE-SEM | ZEISS Shuttle & Find with Corr-Mic Mat sample holder | |
| Weisenberger, C., et al., Multi-scale Characterization of Lithium Ion Battery Cathode Material by Correlative X-ray and FIB-SEM Microscopy, ZEISS Application Note, June 2015 | ZEISS Microscopy | $LiMn_2O_4$ cathode material of a commercial 18650 Li-ion battery | Using an XRM data set as a reference to perform site-specific FIB cross sectioning and tomography | ZEISS Xradia 520 Versa, ZEISS Crossbeam 540 | Correlative ZEISS Atlas 5 software | |
| van der Wal, D., Enhancing Material Inspection and Characterization Information and Data Integrity By Combining Light and Scanning Electron Microscopy in a Correlative Workflow, ZEISS White Paper, Aug 17 | ZEISS Microscopy | Industrial surface coating, printed circuit board, fractured metal rod | Using CLEM to enhance material inspection and characterization | ZEISS Smartzoom 5, ZEISS EVO MA10 | ZEISS Shuttle & Find | ZEISS Shuttle & Find |
| Harris, W., Multi-scale Correlative Study of Corrosion Evolution in a Magnesium Alloy, ZEISS White Paper, Dec. 2015 | ZEISS Microscopy | Magnesium alloys | Correlative tomography study of corrosion of a Magnesium alloy with sub- micron XRM, nanoscale XRM, and FIB-SEM | ZEISS Xradia 520 Vera, ZEISS Xradia 810 Ultra, ZEISS FIB-SEM | ZEISS Atlas 5 | ZEISS Atlas 5 |
| Gelb, J., Investigating Structure-property Relationships in a Carbon-fiber Composite ZEISS Correlative Microscopy, April 2017 | ZEISS Microscopy | Carbon fiber reinforced composite hockey stick | Correlative light, Xray, and SEM to predict mechanical properties | ZEISS Axio Imager 2, ZEISS Xradia 520 Versa, ZEISS Crossbeam 540 | ZEISS Atlas 5 | ZEISS Atlas 5 |

## Raw Materials Industry

| Publication | Journal | Systems / Instruments | Alignment of images from different methods |
|---|---|---|---|
| Loïc Bertrand, Sylvain Bernard, Federica Marone, Mathieu Thoury, Ina Reiche, Aurélien Gourrier, Philippe Sciau, Uwe Bergmann (2015). Emerging Approaches in Synchrotron Studies of Materials from Cultural and Natural History Collections, Springer International Publishing Switzerland 2015 doi:10.1007/s41061-015-0003-1 | Springer International Publishing Switzerland 2015 | X-ray spectroscopy, 3D microtomography, XRF scanning, DISCO beamline, ZEISS Axio Observer.Z1 | |
| Dra. Isabel Guerra Tschuschke, Sébastien Maussang; David Reece , M.Sc. Philipp Vecera, Dr. rer. nat. Siegfried Eigler, Prof. Dr. Andreas Hirsch, Dr. rer. nat. Frank Hauke, Dipl. Ing. (FH) Stefanie Freitag. In situ SEM and Raman investigations on graphene Comparison of graphene, graphene oxide and reduced graphene oxide. ZEISS White Paper, May 2015. | ZEISS Microscopy | ZEISS EsB detector, ZEISS FE-SEM, ZEISS-Renishaw system ensured SEM and Raman measurements | |

## Raw Materials Industry

| Publication | Journal | Systems / Instruments | Alignment of images from different methods |
|---|---|---|---|
| C. Ascaso, J. Wierzchos, and A. De Los Rios. Symbiosis, 24 (1998) 221–234.<br>In Situ Cellular and Enzymatic Investigations of Saxicolous Lichens Using Correlative Microscopical and Microanalytical Techniques. | ResearchGate | ZEISS SEM-BSE, ZEISS CLSM, ZEISS EDS, ZEISS TEM, ZEISS SEM-SE | |
| Michal Shemesh, Sefi Addadi, Yonat Milstein, Benjamin Geiger, and Lia Addadi (2015). Study of Osteoclast Adhesion to Cortical Bone Surfaces: A Correlative Microscopy Approach for Concomitant Imaging of Cellular Dynamics and Surface Modifications.<br>doi:10.1021/acsami.5b08126 | ACS Applied Materials & Interfaces | ZEISS Axiozoom.V16 | |
| Guerra & C. Cardell (2015). Optimizing use of the structural chemical analyser (variable pressure FESEM-EDX raman spectroscopy) on micro-size complex historical paintings characterization. Journal of Microscopy.<br>doi:10.1111/jmi.12265 | Journal of Microscopy | ZEISS FE-SEM | |
| T. Wirtz, P. Philipp, J.-N. Audinot, D. Dowsett and S. Eswara (2015). High-resolution high-sensitivity elemental imaging by secondary ion mass spectrometry: from traditional 2D and 3D imaging to correlative microscopy. Nanotechnology 26 (2015) 434001 (22pp).<br>doi:10.1088/0957-4484/26/43/434001 | Nanotechnology | ZEISS Orion helium ion microscope with an in-house compact high-performance SIMS add-on system. | |
| Jan Goral and Ilija Miskovic, Jeff Gelb and Matthew Andrew (2015).<br>Correlative XRM and FIB-SEM for (Non)Organic Pore Network Modeling in Woodford Shale Rock Matrix.<br>doi:10.2523/18477-MS | ResearchGate | ZEISS Xradia 520 Versa, ZEISS Xradia 810 Ultra, ZEISS Crossbeam 540 | |
| Jung-Kyun Kim, Yong-Eun Kwon, Sang-Gil Lee, Chang-Yeon Kim, Jin-Gyu Kim, Min Huh, Eunji Lee, Youn-Joong Kim (2017). Correlative microscopy of the constituents of a dinosaur rib fossil and hosting mudstone: Implications on diagenesis and fossil preservation. PLoS ONE 12 (10): e0186600.<br>doi:10.1371/journal.pone.0186600 | | ZEISS LEO 1455VP ZEISS Merlin, ZEISS FE-EFTEM, ZEISS Libra MC | |
| Jung-Kyun Kim, Yong-Eun Kwon, Sang-Gil Lee, Ji-Hyun Lee, Jin-Gyu Kim, Min Huh, Eunji Lee & Youn-Joong Kim (2017). Disparities in correlating microstructural to nanostructural preservation of dinosaur femoral bones. Scientific Reports.<br>doi:10.1038/srep45562 | Scientific Reports | ZEISS Axiophot, ZEISS LEO 1475VP, ZEISS Merlin, ZEISS Libra MC | |
| Benjamin Wipfler, Hans Pohl, Margarita I Yavorskaya and Rolf G Beutel (2016).<br>A review of methods for analysing insect structures — the role of morphology in the age of phylogenomics. ScienceDirect. Current Opinion in Insect Science 2016, 18:60–68.<br>doi:10.1016/j.cois.2016.09.004 | ScienceDirect | ZEISS SEM | |
| Carolina Cardell, Isabel Guerra (2015). An overview of emerging hyphenated SEM-EDX and Raman spectroscopy systems: Applications in life, environmental and materials sciences. Trends in Analytical Chemistry. ScienceDirect.<br>doi:10.1016/j.trac.2015.12.001 | ScienceDirect | ZEISS SEM | |
| Stefanie Freitag. ZEISS Scanning Electron Microscopes with Integrated Raman Spectrometers Investigate Solid State Materials. Technology Note September 2015. | ZEISS Microscopy | ZEISS Raman-SEM | |
| Ute Schmidt, Karin Hollricher, Philippe Ayasse and Olaf Hollricher (2015).<br>Correlative RISE microscopy: Raman imaging meets scanning electron probe microscopy.<br>doi:10.1017/S1551929514001175 | ResearchGate | ZEISS SEM, ZEISS EDX | |
| Brian J. Cardotta, Mark E. Curtis (2017). Identification and nanoporosity of macerals in coal by scanning electron microscopy. International Journal of Coal Geology.<br>doi:10.1016/j.coal.2017.07.003 | ScienceDirect | | |
| Steven M. Reddy, Arie van Riessen, David W. Saxey, Tim E. Johnson, William D.A. Rickard, Denis Fougerouse, Sebastian Fischer, Ty J. Prosa, Katherine P. Rice, David A Reinhard, Yimeng Chen, David Olson (2016). Mechanisms of deformation-induced trace element migration in zircon resolved by atom probe and correlative microscopy. Geochimica et Cosmochimica Acta.<br>doi:10.1016/j.gca.2016.09.019 | Geochimica et Cosmochimica Acta | | |
| Paul C. Hackley, Brett J . Valentine, Lenard M. Voortman, Daan S.B. van Oosten Slingeland & Javin Hatcherian (2017). Utilization of integrated correlative light and electron microscopy (iCLEM) for imaging sedimentary organic matter. Journal of Microscopy.<br>doi:10.1111/jmi.12576 | Journal of Microscopy | | |

## Reviews and Protocols

| Publication | Journal | Sample | Application | System | Sample relocation method | Alignment of images from different methods |
|---|---|---|---|---|---|---|
| Kopek, B. G., et al., Diverse protocols for correlative super-resolution fluorescence imaging and electron microscopy of chemically fixed samples, 916, VOL.12 NO.5, 2017, nature protocols, doi:10.1038/nprot.2017.017 | | Aldehyde-fixed specimens prepared by Tokuyasu cryosectioning, whole-cell mount, cell unroofing and platinum replication, and resin embedding and sectioning | Correlative super-resolution fluorescence imaging and electron microscopy | | | Fiducials |
| Hauser, M., et al., Correlative Super-Resolution Microscopy: New Dimensions and New Opportunities, Chem. Rev., 2017, 117 (11), pp. 7428−7456, doi:10.1021/acs.chemrev.6b00604 | | Various | Review of correlative super-resolution fluorescence imaging | | | |
| Kirmse, R., and Hummel, E., Correlative Microscopy Protocols A Reference Guide to Correlative Sample Preparation, Zeiss White Paper, June 2013 | | | Overview of existing sample preparation for correlative microscopy | | | |
| Stempinski, E., S., et al., Correlative Light and Electron Microscopy Techniques: Challenges and Successes, Microsc. Microanal. 21 (Suppl 3), 2015, doi:10.1017/S1431927615005164 | | Cell cultures grown on coverslips, resin sections on coverslips, and resin sections on coated slot grids | Overview of CLEM methods | Laser scanning confocal microscope, ZEISS Sigma HD VP SEM | ZEISS Shuttle & Find and ITO coverslips with fiducial markers | Various software packages |

**Carl Zeiss Microscopy GmbH**
07745 Jena, Germany
microscopy@zeiss.com
www.zeiss.com/corrmic

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