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Editorial

The Transregional Collaborative Research Centre "Fundamentals of Complex Plasmas" (Greifswald – Kiel)*

Jürgen Meichsner[1,a], Michael Bonitz[2], Holger Fehske[1] and Alexander Piel[3]

[1] Institute of Physics, University of Greifswald, 17489 Greifswald, Germany
[2] Institute of Theoretical Physics and Astrophysics, Kiel University, 24098 Kiel, Germany
[3] Institute for Experimental and Applied Physics, Kiel University, 24098 Kiel, Germany

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Starting in 2004, plasma scientists in Greifswald and Kiel (Germany) joined forces with the aim of establishing a common research strategy for new directions in low-temperature plasma physics. Leading research groups at the Ernst-Moritz-Arndt-University Greifswald and the Christian-Albrechts-University Kiel, together with the Leibniz Institute for Plasma Science and Technology Greifswald (INP) and the Max-Planck-Institut für Plasmaphysik (Greifswald branch) provided their expertise in plasma kinetics and dynamics, reactive plasmas as well as plasma theory. On this basis, the Transregional Collaborative Research Centre CRC-24 "Fundamentals of Complex Plasmas" was established in July 2005 by the German Research Foundation (DFG), and has been twice continued after rigorous evaluation at the end of the first (2009) and second (2013) funding period. After three fiscal funding periods comprising a total of twelve years, the CRC-24 was successfully completed in June 2017.

From its inception in 2005, the CRC-24 focused on low-temperature plasmas that become *complex* either by embedded microscopic, electrically charged, solid particles, which form a strongly-coupled subsystem, or by the presence of reactive atoms or molecules interacting with surfaces. The core activities in these subfields initially defined two project areas, A: *Dynamics and Order Phenomena* and B: *Reactivity and Surface Processes*. Within these project areas the following three research fields have been in the focus of investigations in the final funding period from 2013 to 2017:

(i) Correlations and coupling effects in three-dimensional (3D) particle ensembles in plasma confinement, their ordering and dynamic behavior in the presence of wake fields, shielding and magnetic fields.
(ii) Dynamics of multi-component plasmas and plasma-surface interaction involving the plasma sheath dynamics, the build-up of surface charges at internal and external boundaries, the emission of secondary species, and the influence of negative ions and metastables on discharge operation modes.
(iii) Reactive processes in molecular plasmas and at surfaces leading to the synthesis of nano-sized particles, surface modification and deposition of functional thin films and nano-composites.

The papers in this special issue highlight major results from the third funding period and review new experimental, diagnostic and theoretical methods. The papers are assigned to the three areas of research. In the field of dusty plasmas:

- Piel et al. [1] describe experiments and simulations that give a unified view of the role of modes and their preference for shear over compressional motion in the local particle dynamics.
- Advanced Mie-scattering techniques are outlined by Greiner et al. [2], which yield information on particle growth, size statistics and spatial distribution of nanodusty plasmas.
- Ludwig et al. [3] describe how the charge distribution in the wake behind a microparticle in a streaming plasma can be explored with linear response theory, molecular dynamics simulations and experiments.
- In experiments and theory, the influence of weak and strong magnetic fields on particle dynamics and wave spectra is studied by Kählert et al. [4].
- Ott et al. [5] investigate theoretically the role of strong correlations and magnetic fields for transport processes in complex plasmas and discuss extensions to quantum plasmas.

In multi-component plasmas and with respect to plasma-surface interaction:

- Meichsner and Wegner [6] present a detailed modeling approach for the E–H transition in inductively

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[a] e-mail: meichsner@physik.uni-greifswald.de

coupled oxygen rf plasmas in combination and comparison with experimental results.
- Particle-in-cell simulations of capacitive rf discharges are presented by Matthias et al. [7], which illuminate the formation and dynamics of negative ions.
- The progress in the field of plasma-chemical processes in molecular gases with mid-infrared laser absorption spectroscopy and optical emission spectroscopy is reviewed by Röpcke et al. [8].
- A review is given by Bronold et al. [9] on the modeling of the electric double layer formed by the ions in the sheath and the electrons on the surface or inside the solid surface.
- Nemschokmichal et al. [10] study the breakdown of dielectric barrier discharges with streak-camera imaging, laser photo-detachment of negative ions and fluid modeling.

The synthesis of thin films, nanoparticles and nanocomposites is addressed in the third section of papers:

- Schäfer et al. [11] describe thin-film deposition with a non-thermal plasma jet, which is studied with spectroscopic plasma diagnostics, laser-schlieren deflectrometry and fluid modeling.
- Nanoparticle formation in Ar–C_2H_2 plasmas is explored by Hinz et al. [12] with optical emission spectroscopy, I–V probes and multipole resonance probes.
- A comparison of experiments and simulations for the formation of metal-polymer nanocomposites is presented by Abraham et al. [13].
- The formation and modification of metal and metal-oxide nanoparticles in a gas-aggregation source are discussed by Polonskyi et al. [14] in comparison with kinetic Monte-Carlo simulations.

The scientific results of the CRC-24 have been published in 581 peer-reviewed articles, several being highlighted by high-ranking journals. The CRC-24 is particularly proud of the achievements of its young scientists. Student members of the CRC-24 have won 17 "best poster awards" at national and international plasma conferences. Oliver Arp (2007), Christian Henning (2010) and Torben Ott (2012) were the winners of the highly competitive "faculty award" of Kiel University's faculty of Natural Sciences and Mathematics. Sven Bornholdt won the "Familie-Schindler Preis" in physical chemistry (2014) and Rafael Heinisch the Greifswald PhD award (2014). The European Physical Society bestowed the 2007 best dissertation award on Oliver Arp. Dr. Ronny Brandenburg was the recipient of the prestigious Noah-Hershkowitz-Early-Career Award (2014).

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Author contribution statement

All authors have contributed to this text and have endorsed the final MS.

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