**Machine Learning-enabled   
Carbon Nanomaterials-based   
Electronic Olfaction for Gases Identification**

*Gianaurelio Cuniberti*

Institute for Materials Science and Max Bergmann Center for Biomaterials, TU Dresden, 01062 Dresden, Germany

Dresden Center for Computational Materials Science (DCMS), TU Dresden, 01062 Dresden, Germany

[gianaurelio.cuniberti@tu-dresden.de](mailto:gianaurelio.cuniberti@tu-dresden.de)  
<https://nano.tu-dresden.de/gc/>

**Abstract:**

Olfaction is an evolutionary old sensory system, which provides sophisticated access to information about our surroundings. Inspired by the biological example, carbon nanomaterials-based gas sensors in combination with machine learning algorithms aim to achieve similar performance and thus to digitize the sense of smell. In this lecture, the gas discrimination and identification performance of carbon nanomaterials-based (e.g., graphene, carbon nanotubes) nanosensors are presented. Functionalized carbon nanomaterials-based nanosensor were fabricated on both single-channel gas sensor device and multiple-channel gas sensor device, and the sensing signal was acquired upon exposure to various gases. The transient features of gases were then processed from sensing signal and fed to machine learning algorithm in order to discriminate and identify gases. The developed carbon nanomaterials-based electronic olfaction system exhibits excellent gas identification performance towards various gases. The developed platform may facilitate miniaturization of e-noses, digitization of odors, and distinction of various gases, volatile organic compounds (VOCs) in emerging applications, such as pathogen detection, environmental monitoring, disease diagnosis, *etc*.

**References**

1. S. Huang *et al*. Carbon **173** (2021) 262.

2. S. Huang *et al*. Advanced Intelligent Systems **4** (2022) 2200016.

3. S. Huang *et al*. Physical Chemistry Chemical Physics **21** (2019) 24007.

4. A. Panes-Ruiz *et al*. ACS sensors **3** (2018) 79.

5. A. Panes-Ruiz *et al*. Nano Research **15** (2022) 2512-2521.

**Gianaurelio Cuniberti**

*https://nano.tu-dresden.de/gc/*

Professor Gianaurelio Cuniberti holds since 2007 the Chair of Materials Science and Nanotechnology at the Technische Universität Dresden (TU Dresden) and the Max Bergmann Center of Biomaterials in Dresden, Germany. He is a member of the TU Dresden School of Engineering Sciences (Materials Science) and of the School Science (Physics). He studied Physics at the University of Genoa, Italy (where he got his B.Sc. and M.Sc.) and obtained his Ph.D. in 1997 at the age of 27 in a joint collaboration between the University of Genoa and the University of Hamburg, Germany. He was visiting scientist at MIT and the Max Planck Institute for the Physics of Complex Systems Dresden. From 2003 to 2007, he was the head of a Volkswagen Foundation Research Group at the University of Regensburg, Germany. His research activity is internationally recognized in more than 400 scientific journal papers to date. He initiated and organized numerous workshops, schools, and conferences and took part in international research training networks, offering extensive opportunities for young scientists. He has given plenary and invited talks at numerous international meetings. He serves as a referee for numerous high-impact journals, and for several funding research institutions including among others the EU, the German Science Foundation (DFG), the USA National Science Foundation (NSF), the German Israeli Foundation (GIF), and the Alexander von Humboldt Foundation. He received several talent scholarships and awards including the Max Planck Society Schloeßmann award (2001) and the VolkswagenStiftung Research Group Individual Grant (2003). He is a member of several scientific organizations and a corresponding member of the Umbrian Academy of Sciences. Gianaurelio Cuniberti is an Honorary Professor at the Division of IT Convergence Engineering of POSTECH, the Pohang University of Science and Technology since 2009, since 2011 Adjunct Professor for the Department of Chemistry at the University of Alabama, and since 2019 Guest Professor at SJTU. In 2018 he became a faculty member of the transcampus between TU Dresden and King’s College London. Professor Gianaurelio Cuniberti is an elected member of the European Academy of Sciences, of the Academia Europaea and of the Germany National Academy of Science and Engineering (acatech).

