antennas. These devices are typically illuminated by a primary source (single source or array of compact sources) illuminating a laminated metal-dielectric structure [3].

Microwave/plasma interaction: developing circuits integrating plasma zones, studying and improving plasma generation using RF sources [4].

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About the author

Junwu Tao received the B.Sc. degree in electronics from the Radio Engineering Department, Huazhong (Central China) Univesirty of Science and Technology, Wuhan, China, in 1982, the Ph.D degree (with honors) from the Institut National Polytechnique of Toulouse, France in 1988, and the Habilitation degree from the University of Savoie, France in 1999. From 1983 to 1991, he was with the electronics laboratory at INP, Toulouse, France, from 1991 to 2001 has was with the microwave laboratory (LAHC) at the university of Savoie, Chambéry, France, where he was an associate professor in electrical engineering. Since September 2001 he is a full professor at the Institut National Polytechnique of Toulouse. He is a research Fellow with Laboratory of Plasma and Conversion Energy (LAPLACE) and involved in the numerical methods for electromagnetics, microwave and RF components design, microwave and millimeter-wave measurements and microwave power applications. He was a member of the committee that moved the AMPERE association to France in 2008, and continued to take up a constructive role in the life of the association, being a member of the scientific committee up to the present day. He notably organized the 13th AMPERE conference in 2011 in Toulouse, France.

Microwave radiation: A breakthrough for nanotechnnology

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Microwave reactors are used for fast and simple synthesis of materials used in applications such as gas purification, water treatment, energy storage, and drug delivery. While microwave heating is commonly used in households to quickly warm food, microwave ovens can also be used by chemists in advanced laboratories as powerful tools for synthesizing various materials, including nanomaterials.

Thanks to microwave-assisted synthesis, chemists can precisely control nanocrystal size and its surface properties. This often poses a challenge when using traditional techniques and conventional heating methods. Additionally, microwave synthesis is not only significantly faster, but also generally more environmentally friendly when we compare it to other nanomaterial production methods.

There are many publications, including review publications, that highlight the advantages of microwave irradiation in the broad field of nanomaterial synthesis. Their authors emphasize its efficiency, sustainability, and unique ability to fine-tune material properties [1,2]. In recent years, numerous studies have repeatedly demonstrated the remarkable advantages of microwave heating technology over conventional heating methods, including:

- rapid volumetric heating,
- higher selectivity,
- faster chemical reaction rates,
- shorter reaction times,
- greater product yields.

Thanks to microwave technology, we can quickly produce nanomaterials in the liquid phase, resulting in relatively low costs, energy savings, and high efficiency. This also makes the production process move faster towards practical applications [1,2].

The scientists from the Cracow University of Technology (CUT) in Poland, within the Functional Nanomaterials team led by prof. Katarzyna Matras-Postołek, have been successfully using microwave irradiation for many years to control the synthesis of inorganic semiconductor nanomaterials, including sulfides, selenides, and tellurides [3,4]. More recently, they have also focused on carbon nitride materials as potential photocatalysts. Most of the nanomaterials produced show unique optical properties and have been applied as catalysts for the degradation of organic water pollutants.

The CUT team reported [4] the microwave-assisted synthesis of highly crystalline 2D ZnSe and ZnSe:Mn nanoplates in the form of 3D microflowers in just a few minutes (**Figure 1**). They demonstrated that the microwave-assisted solvothermal method results in ZnSe and ZnSe:Mn nanocrystals (NCs) with smaller sizes and higher surface areas compared to those obtained under similar conditions using conventional heating. Additionally, they showed that the photocatalytic activity of the ZnSe:Mn nanoplates under UV light, in the photodegradation of Methyl Orange (MO), exceeded that of the undoped NCs. ZnSe:Mn NCs with 6% Mn doping exhibited significant photocatalytic activity in the degradation of MO under UV light.

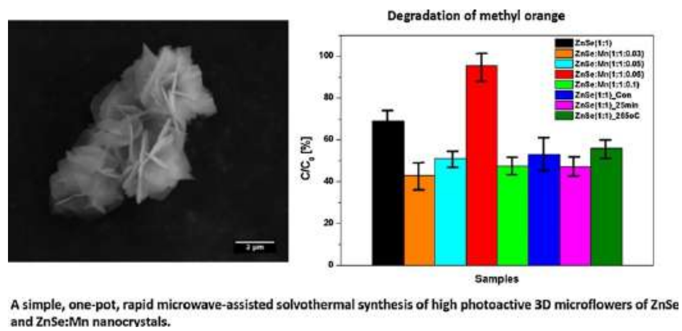

Fig. 1: SEM micrographs of the 3D microflowers of ZnSe NC synthesized by MW irradiation (right) and the comparison of efficiency of photocatalytic degradation of MO for different ZnSe and ZnSe:Mn NCs (left) ([4], (Copyright 2019, Science Direct).

The Functional Nanomaterials group at Cracow University of Technology

Cracow University of Technology is home to an active research group (**Figure 2**), called Functional Nanomaterials, based at the Faculty of Chemical Engineering and Technology. This group is led by Professor Katarzyna Matras-Postołek, who also serves as the Vice-Dean for Evaluation and International Cooperation. The research group focuses on the synthesis and characterization of functional nanomaterials with controlled composition and size, as well as their potential applications, including in optoelectronics and photocatalysis. The luminescent properties of the nanomaterials which the group developed also allow to use the nanomaterials in biology and optoelectronics. The group members have the opportunity to get to know the latest methods of synthesizing inorganic nanomaterials. Their research places significant emphasis on surface modification of the nanomaterials and the impact of stabilizers on their electrical and optical properties. The research group has established strong collaboration with Jagiellonian University in Krakow (Poland), AGH University of Science and Technology in Krakow (Poland), FH Münster University of Applied Sciences (Germany), and University of Jinan (China).

The scientific experience of the group covers the following research areas:

• Development and characterization of inorganic nanocrystals with luminescent properties, including core-shell nanostructures and polymer nanocomposites
• Research on the potential application of nanomaterials in the development of high-performance heterogeneous photocatalysts
• Design of nanomaterials for biosensor applications
• Application of nanomaterials in the development of hybrid optoelectronic devices (photovoltaic cells, electroluminescent diodes)
• Development of inks for printing optoelectronic devices based on nanomaterials
• Surface modification of developed nanomaterials

Fig. 2: Photo of the Functional Nanomaterials Team at Cracow University of Technology lead by prof. Matras-Postołek (Photo by Jan Zych, CUT).

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About the author

Prof. Katarzyna Matras-Postołek, a chemist by education, is a graduate of Cracow University of Technology (CUT). From 2006 to 2012, she worked as a researcher at the Institute for Optical Technologies at Münster University of Applied Sciences in Germany. She earned her Ph.D. from CUT in 2010. After nearly seven years in Germany, she returned to Poland in 2013 to continue her work at CUT. In 2019, she obtained her habilitation in chemistry. Currently, Katarzyna Matras-Postołek is a professor at the Faculty of Chemical Engineering and Technology at CUT. Since 2019, she has been the Vice-Dean for Evaluation and International Cooperation at the Faculty and a Member of the Research Excellence Council of CUT. Her research focuses on functional nanomaterials, particularly semiconductor nanocrystals and their applications in optoelectronics and photocatalysis. She received several prestigious scholarships, including one for outstanding young scientists in Poland (2016). In 2015, she participated in the TOP 500 Innovators program, which included a nine-week internship at the University of California, Berkeley, USA. Since 2014, she has been a visiting professor at the University of Jinan, China, and, since 2019, a scientific member of the international AMPERE organization. She has authored 75 publications listed in the Philadelphia database and has led multiple research projects funded by institutions such as the Foundation for Polish Science (Homing Plus), the National Science Centre (Opus Lap, Sonata Bis, Polonez Bis), the National Centre for Research and Development (Project Lider), and EU funds (Erasmus Project). Katarzyna Matras-Postołek's contributions to applied research have been internationally recognized. In 2015, she was awarded a gold medal at the 43rd International Exhibition of Inventions in Geneva.