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新任教員紹介

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略歴

1970.01 Born in Ukraine
1992.06 Graduated from Chemistry Department, Moscow State University (Russia)
1998.05 PhD in Inorganic Chemistry, Moscow State University (Russia)
1999-2002 Postdoctoral Fellow, The University of Tokyo, Department of Materials Engineering (Japan)
2003-2006 Postdoctoral Fellow, University of Quebec at Chicoutimi (2003-2004), Department of Applied Sciences, and at University of British Columbia (2005-2006), Department of Chemistry (Canada)
2006-2011 Research Professor on Grant, University of Quebec at Chicoutimi, Department of Applied Sciences (Canada)
2011-2013 Researcher, Osaka University, Department of Materials Engineering (Japan)
2013-2018 Associate Professor, Tokai University, Institute of Innovative Science & Technology (Japan)
2018.04 Professor, Tokai University, Research Institute of Science & Technology, then at Department of Mechanical Engineering (Japan)

担当科目

Basic Chemistry

研究活動内容

1. Laser-Produced Nanomaterials

The main research of the group is focused on preparation of nanomaterials with pulsed lasers via ablation in liquid media and application of such materials is photocatalysis, electrocatalysis, gas sensing, as elements of biomedical materials, and in other photovoltaics and sensing related devices. Nanomaterials of different substances are produced in the laboratory: ZnO, $ZnCl_2$, TiO_2, SnO_x, hybrids of ZnO and SnO_x, Au@TiO_2, and so on. Typically, a solid target is immersed in liquid medium and then ablated by a pulsed laser (see Fig.1). The morphology, size, and chemical composition of produced nanoparticles are governed by: (i) laser parameters used (such as pulse energy, duration and frequency); (ii) liquid and its conditions; and (iii) target and its composition.
As a next step, the generated nanoparticles are separated and characterized with various analytical techniques. For

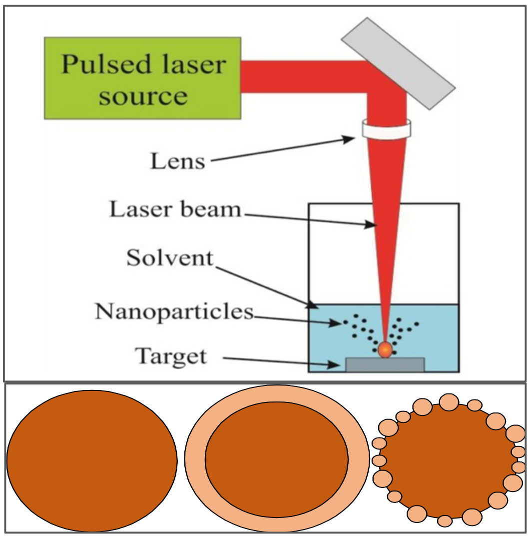

Fig. 1. Schematic presentation of setup used to ablate a solid target in liquid medium and produce nanoparticles (top). Nanoparticles with different morphology: solid nanoparticle, core@shell nanoparticle, and nanoparticle decorated with other nanoparticles (bottom).

different applications, nanomaterials with different morphologies are targeted (see, for example, Fig.1, bottom).

Finally, upon characterization, nanomaterials are tested for different applications. As examples, Fig.2 and Fig.3 show how laser-ablated Sn@SnO_x (Fig.2) and ZnO (Fig.3) nanoparticles responded to ethanol as gas sensors. It is seen that at room temperature, laser-generated nanomaterials could detect alcohol vapors at concentrations as low as 50-100 ppm.

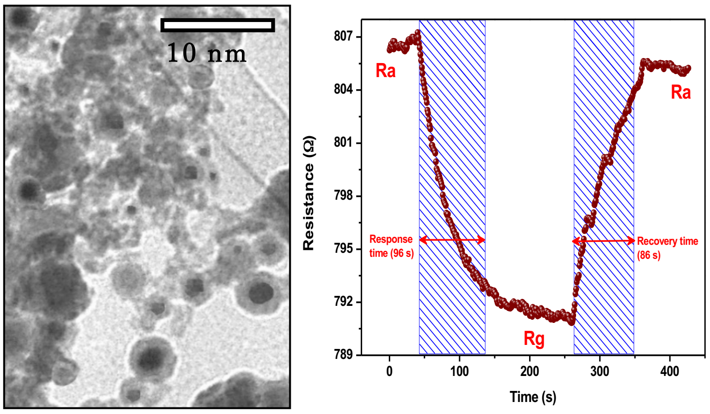

Fig. 2. TEM image of Sn@SnO_x nanoparticles prepared by laser ablation in water (left), and their dynamic response curve to ethanol (100 ppm) at room temperature (right).

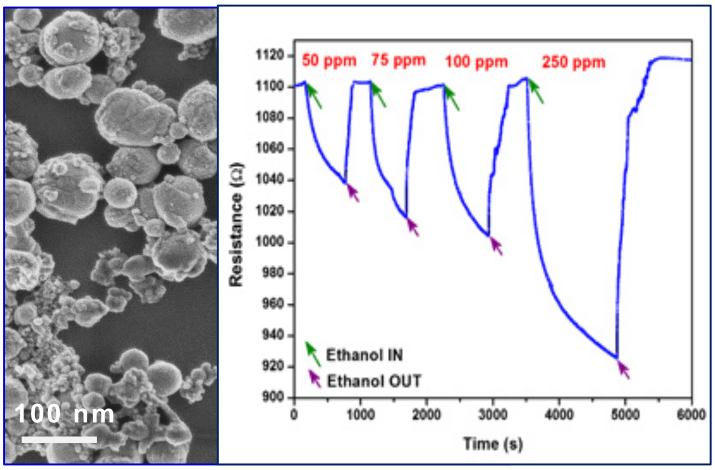

Fig. 3. SEM image of ZnO nanoparticles prepared by laser ablation in water (left), and their dynamic response curve to different ethanol concentrations at room temperature (right).

Apart from gas sensing (based on chemiresistive principles), we also aim to produce nanoparticles for biomedical materials (as containers releasing metal ions or acting as antibacterial agents), for photocatalysis (to decay organic dyes), catalysis, as well as for photonic sensors.

2. Other Research Interests

Among other academic interests where research was (or is currently) conducted are the following fields:

- Anticorrosive coatings on aluminum alloys, their formation mechanism and structure;
- Hydrophobic, super-hydrophobic and anti-icing coatings, their preparation and characterization;
- Development of new efficient catalysts for water splitting and hydrogen evolution;
- Nanomaterials for photocatalytic, optoelectronic, photonic and photovoltaic applications.

Below, Fig. 4 shows an SEM image of permanganate conversion coating grown for a short period of time on polished aluminum alloy AA2024. While the currently used chromate-based conversion coatings are still popular, their replacement by less toxic chemistries has been a subject of very active research for almost three decades. Permanganate-based conversion coatings are considered as one of inexpensive and non-toxic replacements to chromate coatings, and deeper knowledge of how such anticorrosive coatings grow and develop over time is important to understand how their performance can be improved.

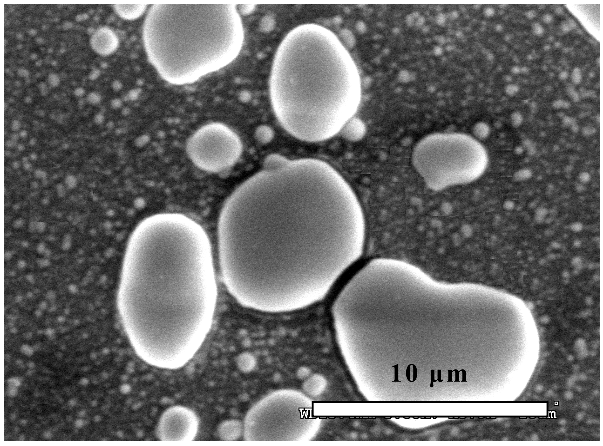

Fig. 4. Surface morphology (SEM image) of a thin layer of permanganate conversion coating grown from chemical bath over aluminum alloys AA2024. At its initial growth stage, the coating is seen to be much thicker over the intermetallic particles of alloy.

3. Representative Publications

1) S. Li *et al.*, ACS Energy Lett. Vol.4, p.1823 (2019).
2) T. Kondo *et al.*, Jpn. J.Appl.Phys. Vol.56, p.080304 (2017).
3) M. Honda *et al.*, Phys. Chem. Chem. Phys. Vol.18, p.23628 (2016).
4) S.A. Kulinich *et al.*, Soft Matter Vol.11, p.856 (2015).
5) S.A. Kulinich *et al.*, J. Appl. Phys. Vol.113, p.033509 (2013).
6) H.B. Zeng *et al.*, Adv. Funct. Mater. Vol.22, p.1333 (2012).
7) S.A. Kulinich *et al.*, Langmuir Vol.27, p.25 (2011).
8) K.Y. Niu *et al.*, J. Am. Chem. Soc. Vol.132, p.9814 (2010).
9) S.A. Kulinich *et al.*, Appl. Surf. Sci. Vol.253, p.3144 (2009).