Keynote

Thu. Jul 31, 2025 10:30 AM - 11:45 AM JST | Thu. Jul 31, 2025 1:30 AM - 2:45 AM UTC Room A & B(2F The SalonThe Grand Ballroom)

[3S03-05] Keynote 4

Chair:Makoto Ogawa(VISTEC and Shinshu University)

10:30 AM - 10:55 AM JST | 1:30 AM - 1:55 AM UTC

[3S03]

[Keynote] Gels and Aerogels from Cellulose Nanocrystals: From Photonics to Supramolecular Chemistry

*Mark MacLachlan[1] (1. University of British Columbia (Canada))

10:55 AM - 11:20 AM JST | 1:55 AM - 2:20 AM UTC

[3S04]

[Keynote] Copper Nanoparticle Systems for Low Temperature Sintering

*Tetsu Yonezawa[1] (1. Hokkaido University (Japan))

11:20 AM - 11:45 AM JST | 2:20 AM - 2:45 AM UTC

[3S05]

[Keynote] Liquid marble stabilized with millimeter-sized particles

*Syuji FUJII[1] (1. Osaka Institute of Technology (Japan))

International Conference on Nanospace Materials 2025@Nagano

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Gels and Aerogels from Cellulose Nanocrystals: From Photonics to Supramolecular Chemistry

Cellulose nanocrystals (CNCs) are obtained from biomass, such as wood and cotton. Typically ~200 nm long and 5-10 nm wide, these rod-shaped particles can form gels in aqueous suspensions. Over the past decade, we have been exploring the gelation of CNCs under various conditions to form supramolecular gels that control guest diffusion,[1] gels with controllable mechanical properties,[2] and stimulus-induced gels.[3] In this talk, I will discuss the controlled gelation of CNCs and its use to create new materials, especially porous aerogels with anisotropic properties.[4,5]

References

1) Zhang, D.; Soto, M. A.; Lewis, L.; Hamad, W. Y.; MacLachlan, M. J. *Angew. Chem. Int. Ed.*, **59**, 4705-4710 (2020).

2) Li, Z., Soto, M. A., Drummond, J. G., Martinez, D. M., Hamad, W. Y., MacLachlan, M. J., *ACS Appl. Mater. Interfaces*, **15**, 8406–8414 (2023).

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4) Li, Z., Co, S., Tsang, K., Drummond, J. G., Martinez, D. M., Hamad, W. Y., Jiang, F., MacLachlan, M. J., *Chem. Eng. J.*, **499**, 156166 (2024).

5) Li, Z., Tsang, K., Xu, Y.-T., Drummond, J. G., Martinez, D. M., MacLachlan, M. J., *J. Mat. Chem. C*, **11**, 18291-18301 (2023).

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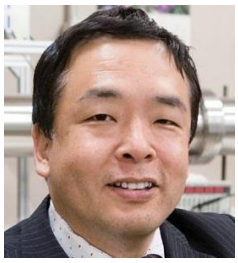

Copper Nanoparticle Systems for Low Temperature Sintering

As power electronics advance, there is increasing demand for cost-effective, high-performance interconnection materials that can be processed at low temperatures. Copper (Cu) nanoparticles are a promising alternative to silver-based materials due to their excellent electrical and thermal conductivity and lower cost. However, the rapid oxidation of Cu nanoparticles poses challenges for low-temperature sintering, often requiring high temperatures or reducing atmospheres.

In this study, we report a low-temperature sintering approach using slightly oxidized copper nanoparticles ($Cu_{64}O$ and Cu_8O), which possess high Cu/O ratios and exhibit enhanced reducibility under mild conditions. These suboxide nanoparticles were synthesized via a wet chemical reduction method using hydrazine monohydrate and then mixed with micro-sized Cu particles to prepare composite pastes. The paste was applied to Cu substrates and sintered at 200 °C under 15 MPa in a nitrogen atmosphere.

The introduction of $Cu_{64}O$ and Cu_8O significantly promoted densification and bonding, achieving shear strengths exceeding 30 MPa. Flake-type Cu microparticles further enhanced bonding performance due to their large surface area. SEM and XRD analyses confirmed the formation of metallic Cu and successful reduction of suboxides. This method enables low-temperature, reducing-agent-free sintering with excellent mechanical and electrical properties.

The developed paste presents a promising solution for next-generation power semiconductor packaging, offering a safe, low-cost, and scalable alternative to conventional bonding materials.

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Liquid marble stabilized with millimeter-sized particles

"Liquid marbles (LMs)" are liquid droplets coated with solid particles adsorbed at the liquid-gas interface and behave as non-wetting soft and elastic objects [1,2]. LMs can be prepared using solid particles with various chemical compositions including organic, inorganic and composite particles. Most of the literature is concerned with the flocs of near spherical particles with nano/micrometers in size. However, there are no studies on LMs stabilized with well-defined non-spherical particles in an independent manner. Thus, it is crucial to reveal and understand the relationship between solid particle shape/size and LM structure formation to utilize the LMs.

In this study, the LMs stabilized with non-spherical particles with millimeter in size are introduced (Figure 1) [3-6]. These LMs consist of liquid droplets stabilized by hydrophobic plates/rods, which adsorb to the liquid-air interface. Depending on the specific combination of plate/rod size and droplet diameter, the plates/rods self-assemble into highly ordered domains. In the case of plate system, even tetrahedral-, pentahedral-, and cube-shaped LMs composed of only 4 to 6 plates are demonstrated. In line with this, highly asymmetric and super-long polyhedral LMs and letters are obtained due to the strong interfacial jamming exerted by the rigid hexagonal plates. This is particularly pronounced for larger plate sizes leading to LMs with unusually sharp edges.

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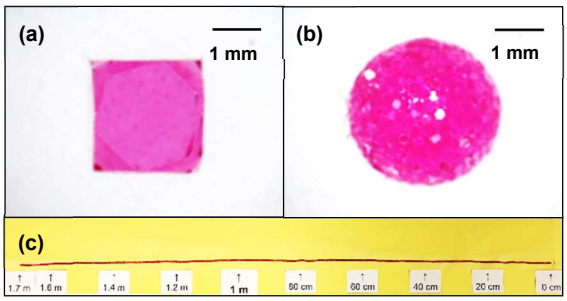

Fig. 1 Digital photographs of LMs stabilized with PET plates: (a) cube-shaped LM (10 μL, 2 mm-sized PET plates) and (b) near-spherical LM (10 μL, 0.2 mm-sized PET plates). (c) Digital photograph of LM with a length of 1.7 m stabilized by 2 mm-sized PET plates.