Application of Silver Nanoplates for SERS

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Introduction

We have successfully developed the manufacturing process for aqueous dispersion of silver nanoplates (AgPL). Simultaneously, the size of AgPL is well-controlled, which obtain the colorful aqueous dispersions arising from the localized surface plasmon resonance (LSPR) of corresponding-sized AgPL. Simple method to fix AgPL on glass substrate has been also investigated. Using the undercoating with modified clay, we found that the LSPR was substantially maintained. In this work, surface enhanced Raman scattering (SERS) of test compounds in the AgPL fixed area was examined.

Ito research institute Co., Ltd. has just established on Apr.1, 2016. Originally, our technology of AgPL manufacturing and handling was developed under a project of **Kyushu univ.**, which was supported by **JST A-STEP** grant (2011-2013).

Features & Spec. of Our AgPL

- ≧99 % tabular particles ⇒ **Photo 1**
- Well-controlled size (20nm～3μm in diameter) ＝ LSPR in visual/near-IR region ⇒ **Photo 2, Fig.1**
- Good storage stability, but polymer dispersant free
- Higher Ag concentration (Max: 0.02 wt%) ⇒ **Photo 3**
- High productivity (Max: 50 liter/batch) ⇒ **Photo 4**

✓ The patent of our AgPL manufacturing process has been already applied (WO2015111095A1).

Photo 1: Images of Our AgPL

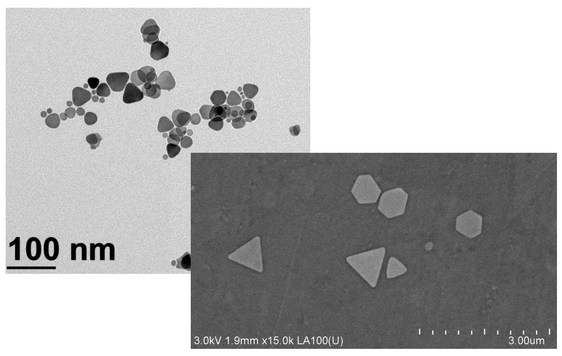
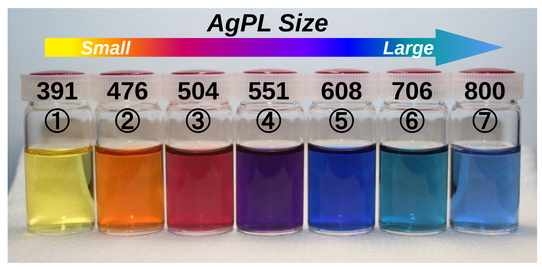


Photo 2: AgPL's LSPR



✓ The peak wavelengths of LSPR in their UV/Vis/NIR extinction spectra are shown in nanometer.

Fig 1: Extinction Spectra of AgPL Aqueous Dispersions

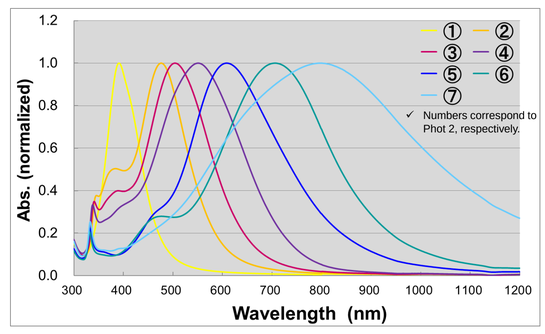
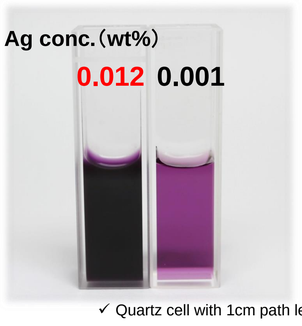
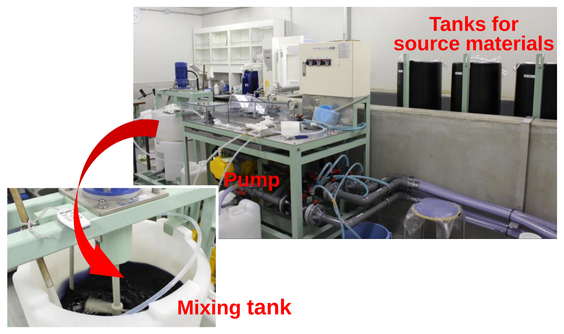


Photo 3: Concentrated AgPL Aqueous Dispersion

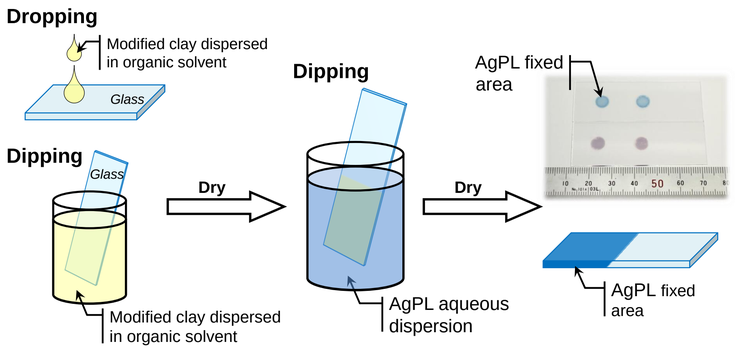


✓ Quartz cell with 1cm path length is used.

Phot 4: Manufacturing mini-Plant for AgPL Aqueous Dispersion



Preparation for SERS Substrate (Our patented process)



Undercoating with Modified Clay **AgPL Adsorption**

Raman Spectrometer

Wasatch Photonics Stroker 785L

- Excitation: 785 nm
- Resolution: 10 cm^{-1}
- Integration time: 1000 msec

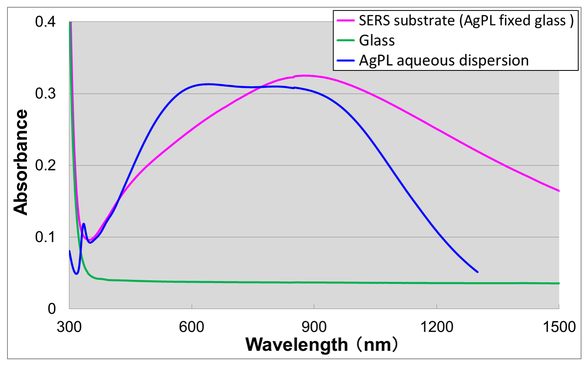
STROKER 785L

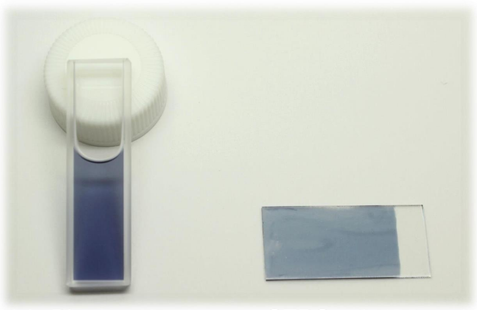
RAMAN SPECTROMETER WITH 785 NM LASER

"Maximum Throughput with Laser in a Small Block"

The Stroker 785L combines our Stroker ƒ/1.3 Spectrometer with our free space VPG stabilized 785 nm laser package to deliver the highest throughput miniature Raman spectrometer on the market. The front end optical module matches the ƒ/1.3 spectrometer input to maintain maximum efficiency. High performance hard coated filters are used to maximize transmission and minimize Rayleigh scattering. A 150mW 785 nm laser is TEC and VPG (Volume Phase Grating) stabilized resulting in ultra stable performance over time and temperature.

Extinction Spectrum of SERS Substrate

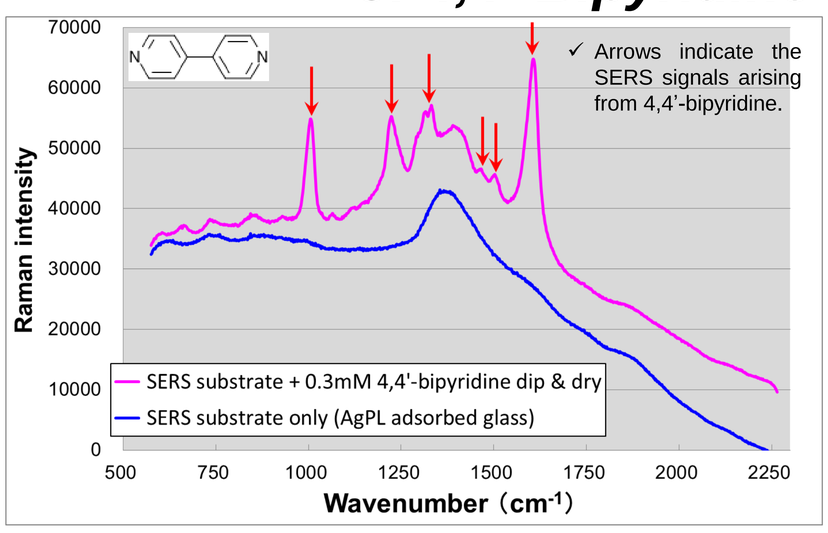




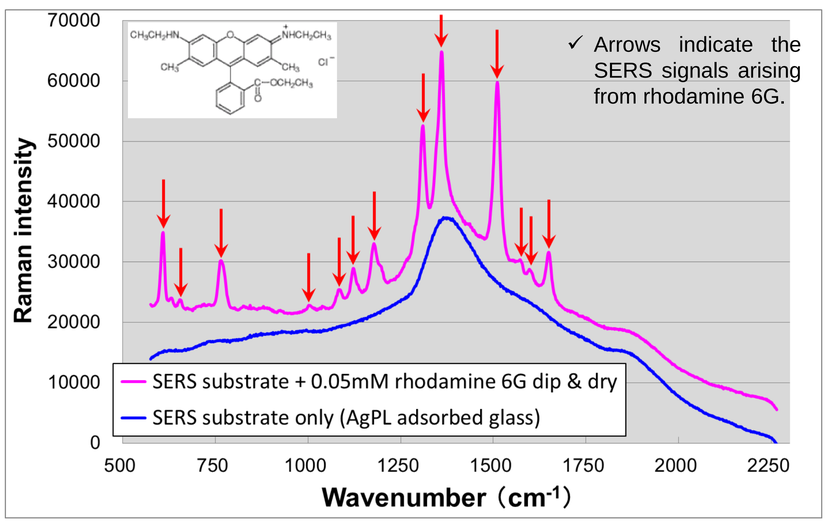
AgPL aqueous dispersion

SERS substrate (AgPL fixed glass)

Raman Spectrum of 4,4'-Bipyridine



Raman Spectrum of Rhodamine 6G

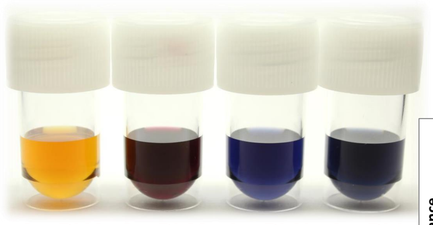


Summary & Acknowledgment

- Our AgPL and its fixing method on glass substrate are effective in SERS, suggesting that the low-molecular dispersant on the AgPL surface is smoothly exchanged for organic compounds which have an affinity with metal Ag.
- We sincerely need partners for the application of AgPL such as SERS. If you have an interest in our technology concerning AgPL, please contact us frankly.
  contact@ito-laboratory.or.jp, http://www.ito-laboratory.or.jp/
- We acknowledge **Nishimatsu construction Co., Ltd.** for the support of this work.

New Release

- AgPL aqueous dispersions (4 items) will be available in October from **Ito research institute Co., Ltd.** (This release schedule is tentative, so it might be delayed.)



Ag-PLY Ag-PLM Ag-PLN Ag-PLI

Ag conc.: 0.003 ～ 0.004 wt%