Proceedings of the 4th World Congress on Electrical Engineering and Computer Systems and Sciences (EECSS'18)
Madrid, Spain – August 21 – 23, 2018
Paper No. ICBES 144
DOI: 10.11159/icbes18.144

Cluster Source Deposition Based Hierarchical Nanoporous Ag Film Deposited Substrate for Surface Enhanced Raman Scattering

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Extended Abstract

By mounting a cluster source on a conventional sputtering system, a new sputtering system is devised for the deposition of nanoporous metal thin films at room temperature. First, the diameter of the nozzle is fixed while the pressure inside the cluster source is kept at several hundreds of mTorr. By adjusting the length of the cluster source, nanoporous films of different thickness can be formed at room temperature. The Raman response characteristics according to the process conditions are then analyzed, and the applicability of the sputtered thin film as a substrate for surface-enhanced Raman scattering (SERS) is examined [1-6].

The Raman intensity increased with increasing thickness and showed a tendency to be saturated approximately 4.3×10^4 cps in 2 μm. As the process pressure increased, the gap between the metal clusters increased and the porosity also increased to 71 - 82%. When the length of the condensation region was varied between 135 mm and 214 mm, the EF of the Raman had a value between 3.97×10^6 and 4.44×10^6. When the partial pressure ratio of He is 7.5%, EF is 4.06×10^6. It increases to 4.4×10^6 when the partial pressure of He is increased to 17.6%. However, it decreases when the partial pressure of He increases further. As for power, we observed that EF is 3.54×10^6 when the power is 120W. It increases to 4.44×10^6 when the power is 140W. However, it decreases when the power is 160W. Therefore, the proposed system takes advantage of an existing sputtering process, and it is possible to form a nanoporous metal film with thickness of several micrometers or more that can be used as a Raman substrate [7-12].

Acknowledgements

This research was supported by the Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (NRF-2017R1D1A3B03034258); the Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (No. NRF-2016R1D1A3A03919627); and the Ministry of Science, ICT and Future Planning (MSIP), Korea, under the Information Technology Research Center (ITRC) support program (IITP-2017-2016-0-00313) supervised by the Institute for Information & communications Technology Promotion (IITP).

References

[1] D. K. Lim, K. S. Jeon, J. H. Hwang, H. Kim, S. Kwon, Y. D. Suh, and J. M. Nam, Nat. Nanotechnol., vol. 6, p. 452 2011.
[2] Z. Wang, L. Tang, L. H. Tan, J. Li, and Y. Lu, Angew. *Chem. Int. Ed Engl*., vol. 51, p. 9078, 2012.
[3] A. Otto, I. Mrozek, H. Grabhorn, W. Akemann, *Journal of Physics: Condensed Matter*, vol. 4, no. 5, p. 1143, 1992.

[4] S. A. Maier, *Plasmonics: Fundamentals and Applications*, Springer, Atlanta, 2007.
[5] J. Stropp, G. Trachta, G. Brehm, and S. Schneider, *Journal of Raman Spectroscopy*, vol. 34, no. 1, p. 26, 2003.
[6] J. F. Li, Y. F. Huang, Y. Ding, Z. L. Yang, S. B. Li, X. S. Zhou, F. R Fan, W. Zhang, et al., *Nature*, vol. 464, p. 392 2010.
[7] W. C. Lin, L. S. Liao, Y. H. Chen, H. C. Chang, D. P. Tsai, and H. P. Chiang, *Plasmonics*, vol. 6, no. 2, p. 201, 2011.
[8] E. D. Diebold, N. H. Mack, S. K. Doorn, and E. Mazur, *Langmuir*, vol. 25, no. 3, p. 1790, 2009.
[9] J. Fontana, J. Livenere, F. J. Bezares, J. D.Caldwell, R. Rendell, and B. R. Ratna, *Applied Physics Letters*, vol. 102, no. 20, p. 201606, 2013.
[10] K. C. Bantz, A. F. Meyer, N. J. Wittenberg, H. Imb, Ö. Kurtuluş, S. H. Lee, N. C. Lindquist, S.-H. Oh, and C. L. Haynes, *Phys Chem Chem Phys*., vol. 13, no. 24, p. 11551, 2011.
[11] H. Qiu, M. Wang, S. Jiang, L. Zhang, Z. Yang, L. Li, J. Li, M. Cao, and J. Huang, *Sensors and Actuators B*, vol. 249, no. 437, 2017.
[12] C. Yang, Y. Qin, X. Zhu, M. Yin, D. Li, X. Chen, and Y. Song, J. *Alloys and Compounds*, vol. 632, p. 634, 2015.