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Three-Dimensional Integrated Micro Solution Plasmas for Nano Materials Processing

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In contrast to the conventional solution chemistry, the solution plasma processing (SPP), which has been invented by Osamu Takai and Nagahiro Saito (Nagoya University), involves accelerated electrons which contribute to generate active chemical species, such as radicals, ions, UV photons and metastable excited atoms. Such active species are expected to enhance through-put of the solution chemistry and to promote the reactions which do not proceed without catalysts. In our previous work, we have successfully obtained glow discharges in water, and applied this technique to modify the surface of nano-materials. Since the previous solution plasma is ignited in a small volume between two stylus electrodes, actual treatment area or volume should be enlarged for practical industrial application. In the case of gas phase processes, large area processing is realized by producing large area plasmas. In the case of SPP, however, large volume plasma in liquid is meaningless, because the most important region is gas-liquid interface. Thus, preparation of large number of tiny plasmas (microplasmas) is rather important in the case of SPP. This can be named as "integrated micro solution plasma." In order to realize the integrated micro-solution plasmas, we have recently utilized interfaces between a plane dielectric plate and porous dielectric material, and successfully obtained large area integrated micro solution plasmas in two dimensions. In this work, we report that three-dimensionally integrated plasmas can be obtained in a porous dielectric material, and demonstrate that Au nano-particles can be synthesized by using this technique. This work has been partly supported by the CREST/JST, the Knowledge Cluster Initiative Tokai Region Nanotechnology Manufacturing Cluster, Grant-in-Aid for Scientific Research on Innovative Areas "Frontier science of interactions between plasmas and nano-interfaces" by the MEXT, and Grant-in-Aid for Scientific Research (C) by the JSPS.