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Large volume liquid treatment with high-density microwave plasma

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Plasma-liquid interaction has attracted much attention for various applications such as water purification, decomposition of liquid waste, biotechnology, agriculture, and material synthesis. For such purpose, dielectric barrier discharges, spark discharges, etc. have been used as the plasma source, because these atmospheric pressure plasma sources are compatible with liquid environment. These discharges also have merit of low power consumption with energy saving. However, some applications such as hydroponic culture, liquid waste management etc. requires large amount of liquid plasma treatment and efficient plasma treatment system is essential.

For efficient liquid treatment, pressure reduction is one of the solutions because the discharge ignition is much easier at reduced pressure condition, not only in the case of DC discharge but also in the case of RF discharge including microwave. Based on this, we made various approach to liquid treatment under reduced-pressure condition using microwave power. In the presentation, effectiveness of the reduced-pressure process will be shown. Furthermore, to realize sustainment of stable plasma close to the liquid surface, an alternative way of liquid treatment set-up is proposed, where reduced pressure is automatically formed by liquid flow with the aid of Venturi effect. This concept also has a merit of compatibility with the liquid treatment because the liquid can be treated with in-line process.

With using this concept, new microwave plasma treatment source will be presented. As an example of the water waste treatment, organic decomposition by the in-line liquid treatment system will be shown. Furthermore, the microwave liquid treatment system is applied to materials processing. Recently, silver nanoparticles have given much attention as silver “nano-ink” in printing electronics. For such application, silver nanoparticles are produced from silver nitrate or other related solutions by the in-line liquid treatment system. By optimizing liquid compound, conversion efficiency to silver nanoparticle was more than 5%, which is promising to suppress production cost of silver nano particles.