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Effects of Atmospheric Pressure Microwave Plasma on Surface of SUS304 Stainless Steel

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Atmospheric pressure microwave induced plasmas are used to excite and ionize chemical species for elemental analysis, for plasma reforming, and for plasma surface treatment. Microwave plasma differs significantly from other plasmas and has several interesting properties. For example, the electron density is higher in microwave plasma than in radio-frequency (RF) or direct current (DC) plasma. Several types of radical species with high density are generated under high electron density, so the reactivity of microwave plasma is expected to be very high [1]. Therefore, useful applications of atmospheric pressure microwave plasmas are expected.

The surface characteristics of SUS304 stainless steel are investigated before and after surface modification by microwave plasma under atmospheric pressure conditions. The plasma device was operated by power sources with microwave frequency. We used a device based on a coaxial transmission line resonator (CTLR). The atmospheric pressure plasma jet (APPJ) in the case of microwave frequency (880 MHz) used Ar as plasma gas [2]. Typical microwave Pw was 3-10 W. To determine the optimal processing conditions, the surface treatment experiments were performed using various values of Pw (3-10 W), treatment time (5-120 s), and ratios of mixture gas (hydrogen peroxide). Torch-to-sample distance was fixed at the plasma edge point. Plasma treatment of a stainless steel plate significantly affected the wettability, contact angle (CA), and free energy (mJ/m^2) of the SUS304 surface. CA and γ were analyzed. The optimal surface modification parameters to modify were a power of 10 W, a treatment time of 45 s, and a hydrogen peroxide content of 0.6 wt% [3]. Under these processing conditions, a CA of just 9.8^o was obtained. As CA decreased, wettability increased; i.e. the surface changed from hydrophobic to hydrophilic. From these results, 10 W power and 45 s treatment time are the best values to minimize CA and maximize γ.

Keywords: Atmospheric pressure plasma, Microwave plasma, Surface treatment, Contact angle