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Gliding arc surface treatment of glass fibre reinforced polyester enhanced by ultrasonic irradiation

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During atmospheric pressure plasma surface treatment, reactive species generated in the plasma diffuse through a boundary gas layer which sticks at the material surface. Due to the short lifetime of these species only a small fraction can reach the surface, limiting the surface treatment efficiency. It is reported that powerful ultrasonic waves with a sound pressure level (SPL) above approximately 140 dB can reduce the thickness of the boundary gas layer, and that the treatment efficiency of an atmospheric pressure dielectric barrier discharge is highly improved by the simultaneous ultrasonic irradiation onto the surface. In the present work glass fibre reinforced polyester (GFRP) plates are treated using an atmospheric pressure gliding arc discharge with and without ultrasonic irradiation to study adhesion improvement. The gliding arc was generated between divergent electrodes by utilizing an alternating current power supply at the power ranging between 250 and 500 W. The arc was extended by a high speed air flow. The air flow at the arc ignition directed the GFRP surface at an angle of approximately 30^{o}. The ultrasonic waves of the frequency diapason between 20 and 40 kHz at the SPL of approximately 150 dB were introduced vertically to the GFRP surface through a cylindrical waveguide. The water contact angle of the GFRP surface dropped markedly with no ultrasonic irradiation, and tended to decrease furthermore at higher power. Ultrasonic irradiation during the plasma treatment consistently improved the wettability. The polar component of the surface energy changed from 12 mJ m^{-2} to approximately 66 - 74 mJ m^{-2} after the gliding arc treatment, and increased by up to approximately 10 mJ m^{-2} with ultrasonic irradiation, but showed no significant change at different arc powers. It is seen that polar functional groups were introduced at the surface by the gliding arc treatment, and that the treatment efficiency was enhanced by the ultrasonic irradiation, indicating that the adhesive property would be improved. The results are extensively discussed in terms of the plasma conditions, and the properties of the treated GFRP surfaces.

Keywords
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