Fluctuation Phenomena of Plasma Jet in Long DC Arc with Ring-Shaped Anode

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A long DC arc with a ring-shaped anode wassuccessfully established for the purpose of an improvement of energyefficiency. The long DC arc is one of the most attractive thermal plasmasources due to its advantages such as large plasma volume and long residencetime of treated gas. The long DC arc system with a hemispherical shaped anodehas been developed and utilized in industrial fields for harmful gasdecomposition such as perfluorocarbons. However, further improvements in termsof energy efficiency and processing rate are essential toexpand the applications of the long DC arc system because more than 50% ofenergy was lost at the conventional hemispherical anode. In the present work,the ring-shaped anode was introduced to convert the large energy loss at theanode into the plasma jet flow. Calorimetric measurement indicated that 60% ofthe energy loss at the anode in the conventional hemispherical anode wasconverted into the plasma jet flow when the ring-shaped anode was utilized.Effects of plasma gas flow rate, arc current, and external magnetic fields onthe plasma jet fluctuation were clarified on the basis of the high-speed cameravisualization with synchronized measurement of arc voltage fluctuation. Largergas flow rate led to rapid arc fluctuation due to the restrike phenomena in thelong DC arc torch. Plasma jet fluctuations were attributed to the arcfluctuation of restrike phenomena and eddy formation due to the entrainment ofsurrounding cold air into the plasma jet. Understanding of fluctuationphenomena enables us to establish innovative thermal plasma processing.