Investigation of Compositional Effect of Mixed Gas on Plasma Velocity Generated by Plasma Focus Device

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Cosmic rays (CRs) in space are considered accelerated ions originating from collisionless shocks. Collisionless shocks are shock phenomena caused by the interaction between charged particles and electromagnetic fields. The interaction of solar wind with interstellar magnetic fields is one example to form collisionless shocks. Since the solar wind consists of various species of ions, it may form various species of CRs. The particle acceleration mechanism in collisionless shocks is unclear, even though various numerical simulation studies and laboratory-scale experiments have been conducted. In this study, we performed a laboratory-scale experiment using a pulsed-power discharge to understand the compositional effect of mixed gas plasma on collisionless shocks. To generate fast plasma flow using the pulsed-power discharge, Tapered Cone Plasma Focus Device (TCPFD) was used. The discharge experiments were performed for various compositions of He and Ar gases at the controlled pressure of 0.5 Pa. The ratio of the number density of Ar and He in the mixed gas plasma was controlled by the flow rate of each gas. The plasma flow's self-emission and ion current waveform was measured using a streak camera and a Faraday cup. The experimental results showed that the velocity of the mixed gas plasma decreases and the peak time the bulk of ions takes to arrive at the detector increases with the increase of the Ar percentage in the mixture. Since Ar is heavier than He, the increase in the Ar percentage means an increase in the average mass of the mixed plasma, it affects the velocity and the peak time of the ion current. We conclude that the composition of the mixed gas affects both the velocity and arrival time of the plasma flow generated by the TCPFD.

Keywords: Collisionless Shock, Pulsed-Power Discharge, Plasma Focus, Mixed Gas Plasma, Fast Plasma Flow