Performance and Plasma Characteristics of Low-Power Ammonia Arcjet Thruster

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In recent years, with the rapid development of small satellites, low-powerarcjet thrusters of 100W-class have attracted more attention from theresearchers, being simple in structure, compatible with the satellitesystem, and so on. Ammonia has the advantages of high density,ease of liquefaction and carrying on board, and relativelyhigh specific impulse, thus could beconsidered as a kind of suitable propellant for propulsion. There have beenstudies on the ammonia arcjet thrusters at electric power around kilowatt-classor more than 20 kilowatts in the past [1-3], but studies at electricpower below 100W are still scarce. It is not easy to achieve stable dischargestate under small gasflow rate and small currentconditions with ammonia propellant, and work needs to be done in order toobtain the stable discharge state under such working conditions.

In this study, a low-power arcjet thruster of 100W-class with natural-radiation-cooledнozzle was fired ina vacuum chamber at pressure kept below 1 Pa, and the thrust produced by the arcjetthruster was indirectly measured by the impinging force method [4].Thruster performance, i.e., specific impulse and thrust efficiency, anddischarge characteristics of the arcjet thruster have been systematicallystudied. Thephotos of the arc discharge within the nozzle throat were taken by using a 45° inclined copper mirror and an ICCD camera. Experimentalresults show that the arcjet thruster can be stably operated with good repeatability. The maximumspecific impulse of the thruster is up to 340s, and the maximum thrust efficiency exceeds40%. The end-on photos indicate thatthe arc column passes throughthe nozzle throat and the arc-root is circumferentially attached to theexpansion section of the nozzle. Compared to cold NH_3 thruster, thearc-heated one may hold certain advantages inprospective applications on small satellites.

Keywords: Low-power arcjet thruster, Ammonia propellant, Specific impulse?Thrust efficiency,Discharge characteristics

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