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PROGRESS IN RESEARCH AND DEVELOPMENT OF SUPERCONDUCTOR-BASED APPLIED-FIELD MAGNETOPLASMADYNAMIC TECHNOLOGY

Abstract

Applied-Field Magnetoplasmadynamic (AF-MPD) Thrusters are among the most widely-researched electric propulsion technologies. This research has been motivated by the unique set of characteristics offered by the technology, namely propellant flexibility, throttleability, high specific impulse, high thrust density, and scalability. As such, AF-MPDs have long been considered a prime candidate for several mission scenarios, in particular those requiring high powers. Despite this, research in the technology had been largely diminished due to issues associated with electromagnet power consumption and thruster lifetime. The last decade has seen a renaissance in AF-MPD research, with prototypes built in Germany, Italy, Japan, China, and Russia. Leading research efforts in AF-MPD, the University of Stuttgart have achieved the most promising results to date with the 100kW-class SX3 thruster, with thrust efficiencies as high as 62Efforts are currently underway in Germany to commercialise HTS-based AF-MPD technology, led by Neutron Star Systems and the University of Stuttgart, with the primary focus on the development of the SUPREME technology: superconductor-based thrusters for power levels greater than 5kW. While HTS coils are needed to increase the flight feasibility of the technology, they also present a number of engineering challenges and opportunities which NSS is currently addressing, related for example to the Power Processing Unit and the Thermal Management System. Furthermore, the topic has seen an increased traction worldwide with parallel development programs now underway in New Zealand, Russia, and China. This paper reviews the latest advances in AF-MPD and HTS developments and presents the SUPREME design concept. The technological roadmap, and the latest developments on a both a subsystem and system level are presented. The global RD landscape for superconductor-based AF-MPD is discussed and contextualised with respect to candidate flight missions.