

IAF SPACE PROPULSION SYMPOSIUM (C4)  
Propulsion System (2) (2)

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GREEN FUELS FOR ROCKET PROPULSION: CURRENT STATUS AND FUTURE PERSPECTIVES  
OF PARAFFIN-BASED FORMULATIONS**Abstract**

In the past, space flight and orbit injection missions were prerogative of government agencies. Nowadays, the increasing participation of private actors fostered the research of propulsive systems featuring simplicity, safety, low-cost, and reduced environmental impact. These requirements can be satisfied exploiting hybrid rocket engines. Nevertheless, their use has been limited by slow regression rate of the conventional fuels, that is reflected in low-thrust levels. Paraffin wax fuels promise to overcome this limitation thanks to the entrainment of melted fuel droplets. However, paraffin wax alone cannot be used in operating systems because it is unsuitable for withstanding loads associated to the pre-launch and launch activities. Several studies are currently aiming at reinforcing paraffin grains using additives. Typically, this process has a detrimental effect on the fuel regression rate. To date, enhancing mechanical properties of paraffin-based fuels without reducing the ballistic behaviour is still an unanswered question.

The Space Propulsion Laboratory (SPLab) of Politecnico di Milano is active in the research of paraffin-based fuels fulfilling both the structural and ballistic requirements. A new approach of reinforcing paraffin solid fuels has been conceived exploiting the use of purposely 3D-printed mechanical supports for the paraffin fuel material. These reinforcing structures may serve as an additional fuel component. Different 3D printed elements involving various materials will be numerically and experimentally investigated inspecting their structural and burning behaviour. The paper aims at presenting the possibility of producing a new generation of high performance paraffin-based fuels featuring both structural and combustion performance. The final goal is the full exploitation of the hybrid rocket propulsion main features, and, in particular, the development of a green and competitive solution for different aerospace applications including the small launcher market. The latter is crucial for a sustainable exploitation of the social fallout possibilities offered by new generation space missions based on small satellites.