Measuring Thrust of Pulsed Plasma Thruster Using UV Resin Made with 3D Printer and Combination of UV Resin and Ionic liquid

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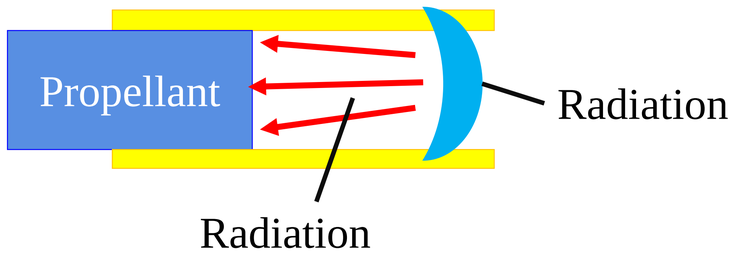
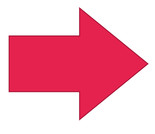
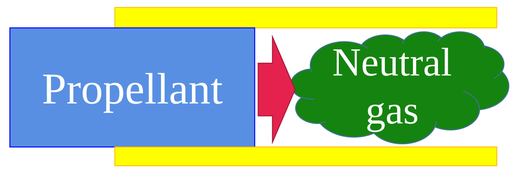
Pulsed Plasma Thruster Issues

Relatively low thrust efficiency than other type electrical thruster due to the poor propellant utilization.

・“Late Time Ablation (LTA)“







The neutral gas cannot contribute to thrust because it cannot receive Lorentz force .

Wasting energy

Solution

Combining propellant of ionic liquid and solid propellant

Putting ion liquid to resin propellant each halls

Expected that:

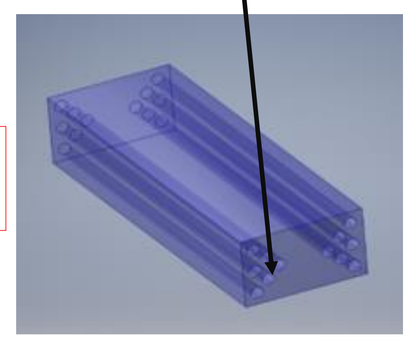
・To remove viscosity resistance between liquid and wall

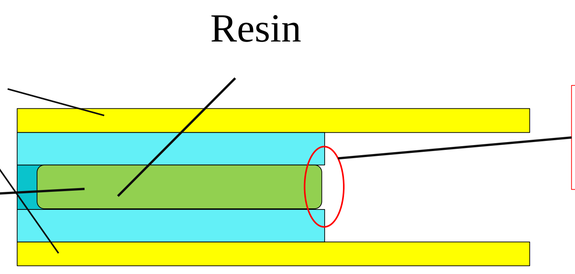
・ionic liquid will be plasma due to the radiation from ambient UV resin plasma

・To get high thrust per supplied energy

Properties of ionic liquid in this case

Melting point	13℃
Decomposition temperature	354℃
Viscosity	37 mPa・s
Density	1.28g/cm^3
Electrical conductivity	14 mS/cm at 25 ℃
Specific heat	1.556 j/Kg at 25 ℃





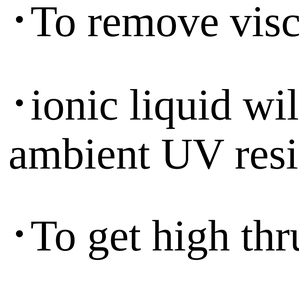
Turning ion liquid into plasma with resin

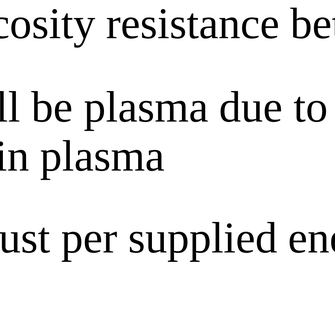
Experiment

Experiment purpose

・Try to measure thrust of three types propellants.

・Evaluate UV resin and combination propellant by comparison with PTFE.

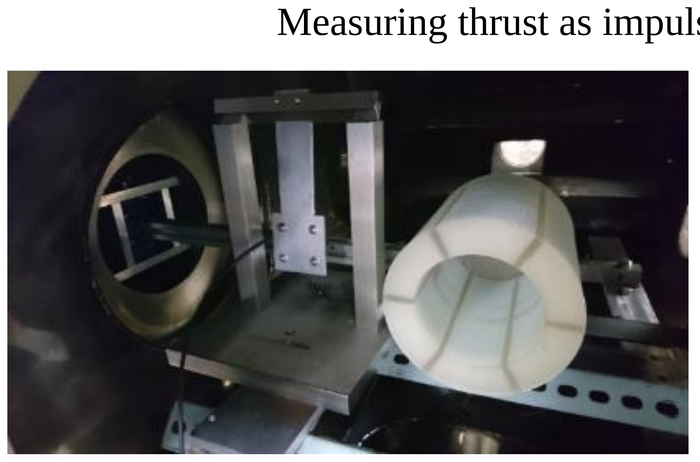




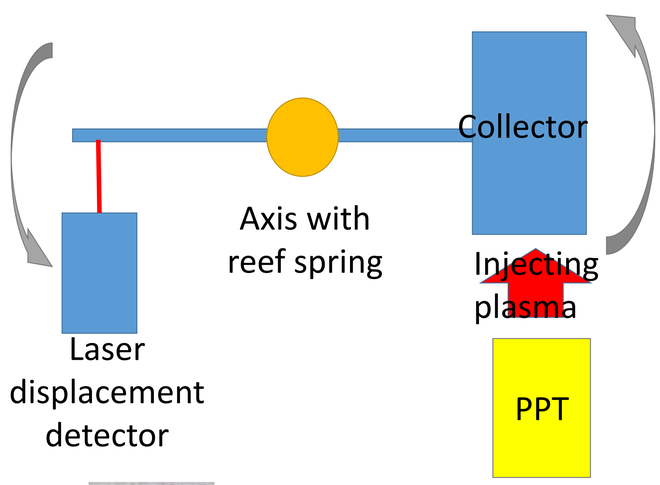
Experimental thruster parameters

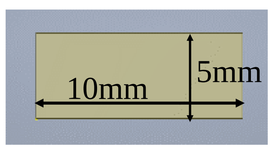
Operation Mode	Magnetodynamic
Capaciance [μF]	25
Charge Voltage [V]	500
Pulse Energy [J]	3.13
Igniter Voltage [V]	4800 (AC60 Hz)
Electrode Material	Copper
Electrode Gap [mm]	10 × 5 (W × H)

Measuring thrust as impulse bit (N・s) in vacuum



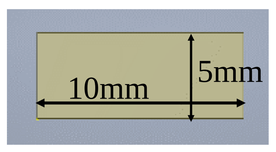
Thrust stand overview (Measuring system)





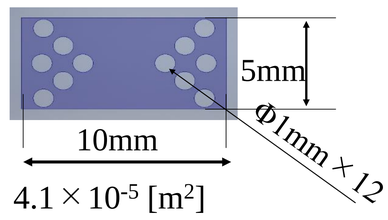
5.0 × 10^{-5} [m^2]

•Polytetrafluoroethylene(PTFE)
(commonly used in PPT)



5.0 × 10^{-5} [m^2]

UV resin
(made with 3D printer)



4.1 × 10^{-5} [m^2]

18.8% ion liquid

UV resin with Ion liquid

Result and discussion

The obtained data of input and output.

	UV Resin	PTFE	UV Resin and Ion liquid
Voltage in capacitor (before)[V]	491.4	497.2	276
Voltage in capacitor (after)[V]	28.4	32	0
Subtraction voltage[V]	461	465.2	276
Consumed energy[J]	2.66	2.71	0.95
Impulse bit[N・s]	6.8 × 10^{-6}	9.0 × 10^{-6}	10.1 × 10^{-6}
Momentum coupling coefficient[N・s/J]	2.6 × 10^{-6}	3.3 × 10^{-6}	11.3 × 10^{-6}

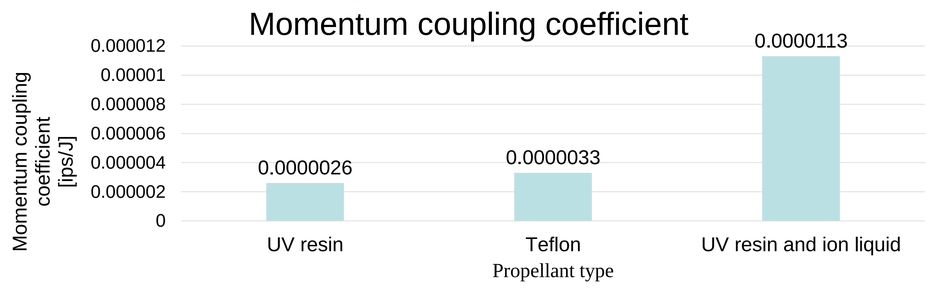
・Momentum coupling coefficient of combination propellant is approximately 3.5 times higher than PTFE.

→ This fact indicates potential that applying ionic liquid as PPT propellant is effective to improve PPT performance.

・possible to eject ionic liquid smoothly

・The combination propellant operation failed with 500 V charge due to unintentional work while capacitor charging.

→Possible leak of ionic liquid



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