

A REVIEW ON ENVIRONMENTALLY FRIENDLY HALOGENATED SALTS FOR SUSTAINABLE PYROTECHNICS



Author: Huang Kede (ST Engineering)

Thesis advisor: Dr. Lisa Humphreys, Dr. Christine McGee, Miss Niki Darcy
MSc in Explosive Ordnance Engineering

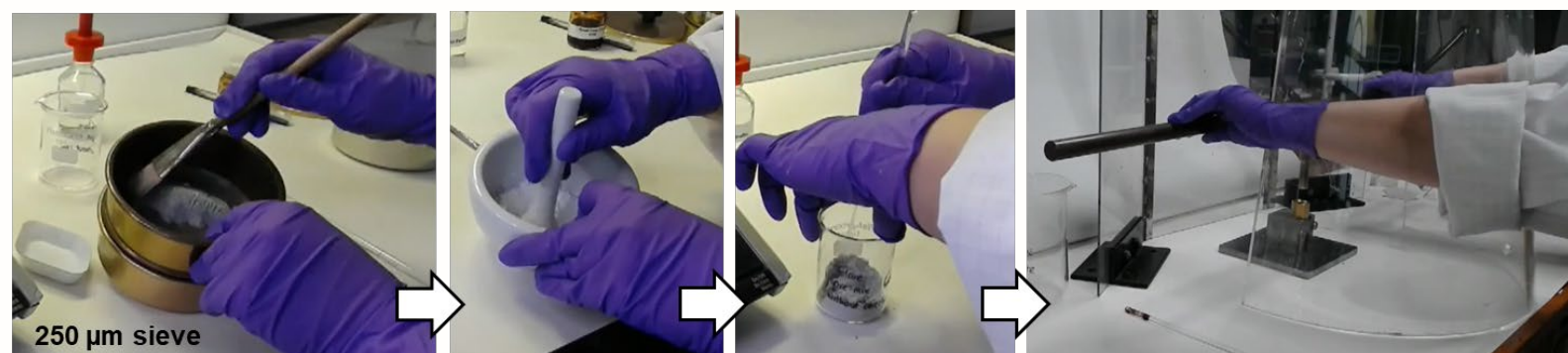
Can we create an eco-friendly pyrotechnics?

Traditional Red Flare

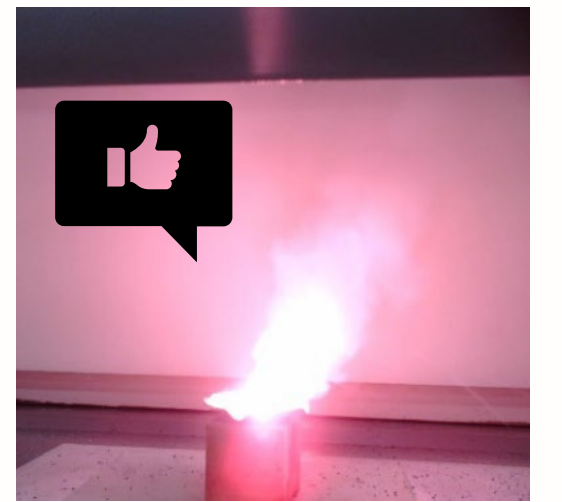
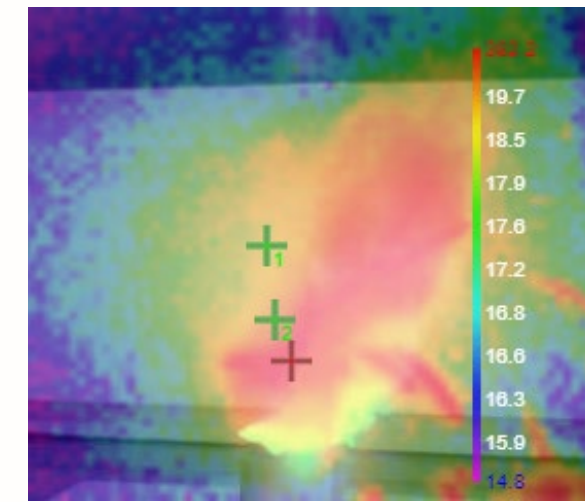
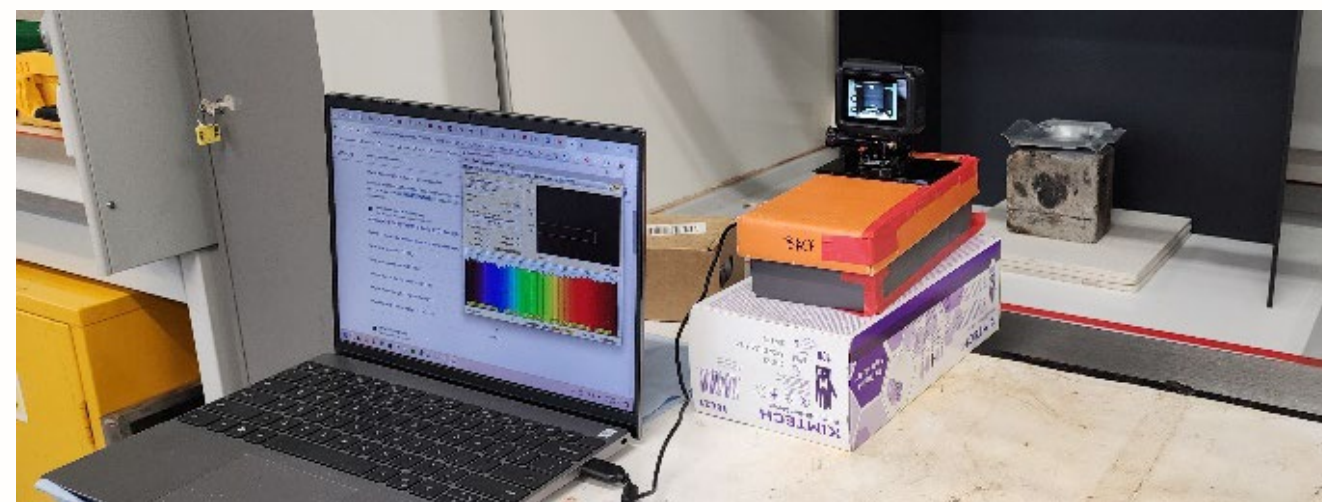
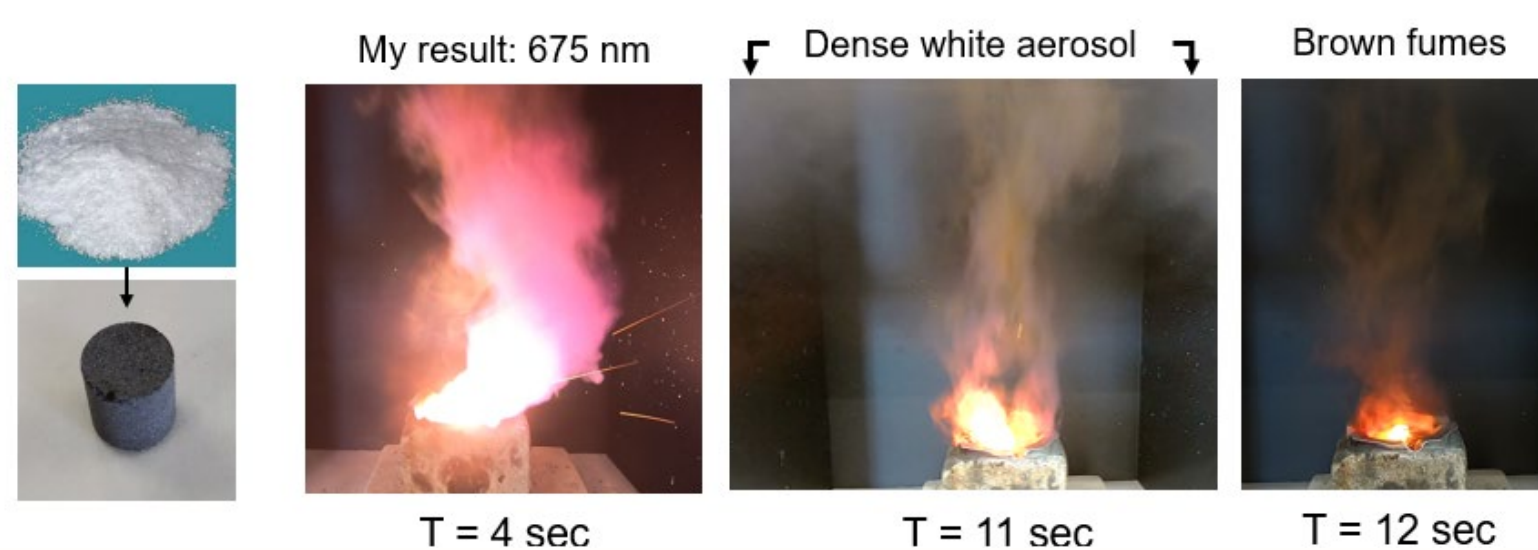
Role	Ingredient	%wt
Plasticizer	Paraformaldehyde	1%
Fuel	Carbon	2%
Chlorine Donor	Cereclor 70	6%
Binder	Resin & Paraffin	14%
Colorant	Strontium Oxalate	14%
Oxidizer	Potassium Perchlorate	63%

Eco-Friendly Red Flare

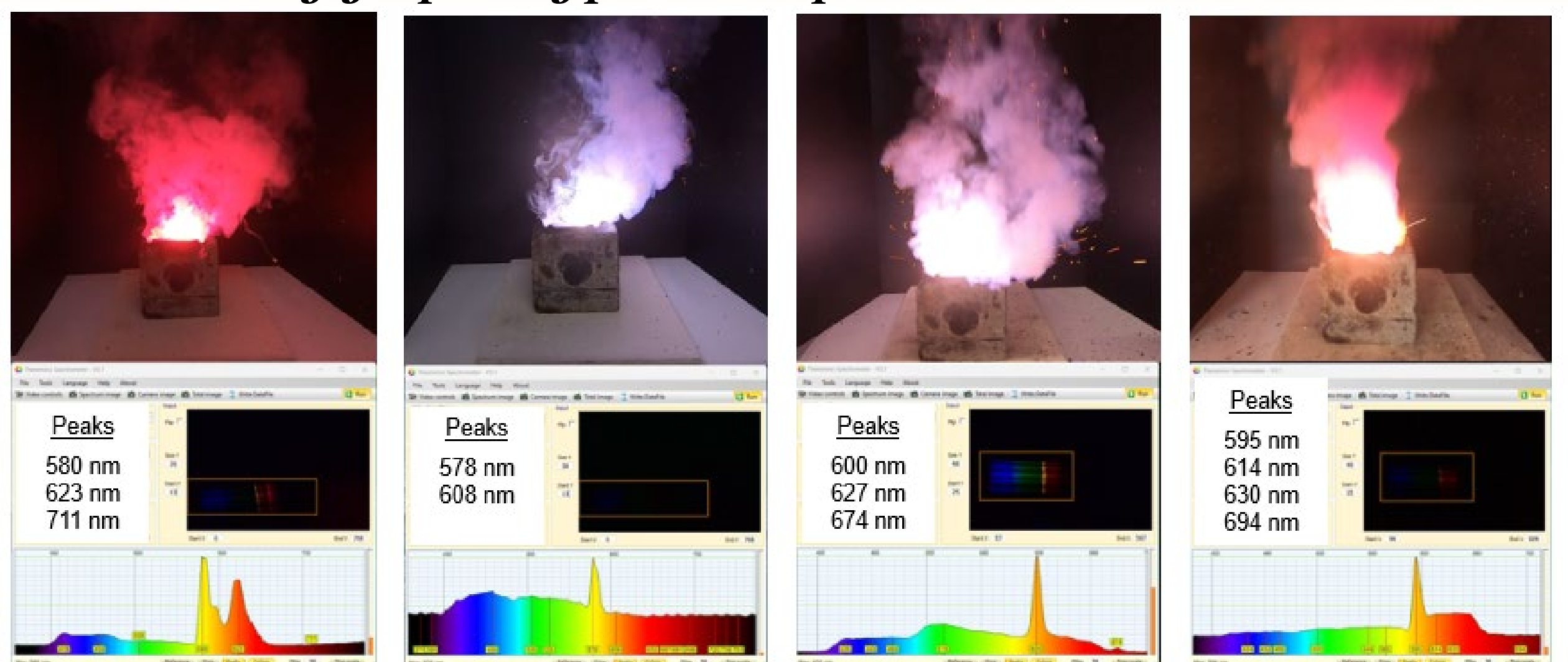
Role	Ingredient	%wt
Plasticizer	Paraformaldehyde	1%
Fuel	Carbon	1%
Fuel	Magnesium/Aluminium 50:50	5%
Binder	Resin & Paraffin	7%
Colorant & Oxidizer	Lithium Iodate	86%



• Assumed Decomposition Mechanism [11]:



Increasingly replacing potassium perchlorate with lithium iodate



Conclusion

- Lithium Iodate and Calcium Iodate-based flares can achieve high spectral purity without chlorine.
- Fuel-rich mixture is required to achieve stable combustion and avoid strobing effect.
- Traditional Perchlorate-based pyrotechnics can cause thyroid disruption through soil and water contamination
- However, eco-friendly flares are more expensive as traditional perchlorate-based flares.

Yes, We Can!

Future Work

- Safety and life-cycle assessment - degradative ageing problem with metal iodate flares
- Formulation Optimization - Introducing energetic iodate salt = aluminium iodate hexahydrate $\text{Al}(\text{H}_2\text{O})_6(\text{IO}_3)_3(\text{HIO}_3)_2$

References:

1. Steinhauser, G., & Klapötke, T. (2008). "Green" Pyrotechnics: A Chemists' Challenge. Angewandte Chemie International Edition, 47(18), 3330-3347. doi:https://doi.org/10.1002/anie.200704510
2. https://www.bbc.com/future/article/20240703-how-4-july-fireworks-pollute-the-air-and-might-damage-your-health