Nitrocellulose and Nanomaterials: Understanding the fundamental interactions between nitrocellulose and graphene

Graphene in the Energetic World

Graphene is the lightest and strongest nanomaterial ever known. Its mechanical strength is 100-300 times more than steel and has unparalleled thermal and electrical conductivity. Graphene has shown great potential for influencing thermal decomposition[1], ignition temperatures[2] and burn rate[3] of energetic materials.

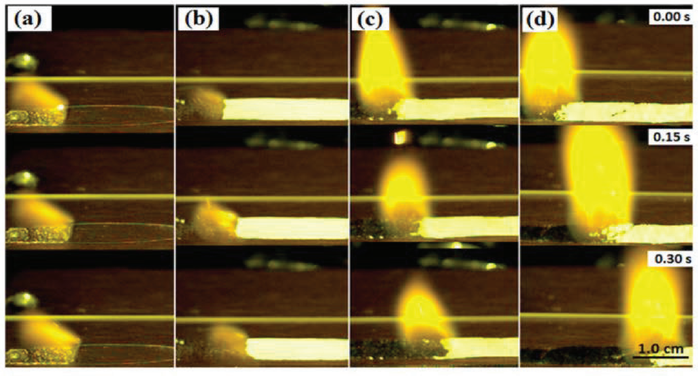
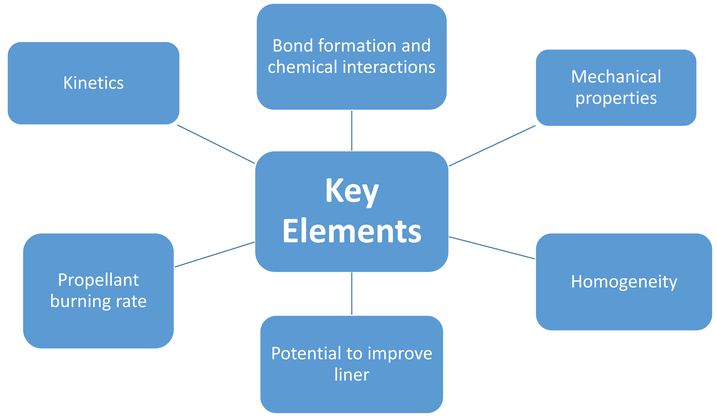
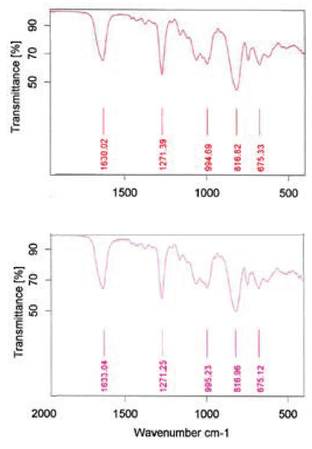


Fig. 1. High speed images of combustion process of pure NC films and GO-NC films in ambient conditions: (a) Pure NC film; (b) 0.05% GO-NC film; (c) 0.5% GO-NC film; (d) 1% GO-NC film. [4]

However, the fundamental science of graphene and energetics interaction remains unclear.

This PhD project is to study the interaction of graphene with nitrocellulose, which is believed to enhance the mechanical and ballistic (burn rate) properties of NC-base propellants.





ATR-FTIR analysis has shown that the presence of graphene shifts the asymmetric NO_2 stretching vibration.

It has been found that in cellulose and nitrocellulose that such upward shifts can be used to determine crystallinity in nitrocellulose[5].

It is intended to determine if this can be exploited across a range of nitration levels in NC, with and without graphene by correlation with XRD.

Aims

Investigate the fundamental interactions of NC with graphene-derived nanomaterials using:

- Sum Frequency Generation Vibrational Spectroscopy
- FTIR
- Solid State NMR
- RAMAN spectroscopy

Establish better understanding of graphene - nitrocellulose surface interactions.

Determine the influence on various characteristics of propellants primarily the burning rates of modified and unmodified propellants.

Examine possibility to determine crystallinity in NC by FTIR

Success of this programme will widen the application of graphene in the field of Energetics Chemistry to improve munition performance and safety.

References

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