Outline

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Project Objectives

- Develop a family of small caliber infrared (IR) cartridges in 5.56mm, 7.62mm and 12.7mm calibers.
- Develop tracer and igniter compositions visible predominantly through Gen II NVG (Night Vision Goggles).

Source: Gamma Scientific  [www.gamma-sci.com](http://www.gamma-sci.com)
Project Objectives

- Define, for each caliber:
  - Design parameters
  - Process parameters
- Use same projectile jacket and cores of visual tracers
- Use same machinery and tooling as visual tracers
- Meet NATO standard trace distances and testing protocols, but in IR.
- Use GD OTS Canada patented IR Tracer Mix.
**Non-toxic boron-containing IR tracer compositions and IR tracer projectiles containing the same for generating a dim visibility IR trace**

**US 8066833 B2**

**SUMMARY**

A novel non-toxic IR tracer composition is provided herein which, when incorporated into an IR tracer projectile which is then fired, generates a dim visibility IR trace. Such IR tracer composition is a non-toxic, boron-containing, IR tracer composition comprising: from about 20 to about 30% by weight, or from about 45 to about 60% by weight, of potassium perchlorate; from about 5 to about 16% by weight of a metallic fuel which consists of boron; from about 20 to about 25% by weight, or from about 40 to about 50% by weight, of a non-metallic fuel which consists of sodium salicylate; from about 5 to about 10% by weight of a retardant which consists either of iron carbonate or magnesium carbonate; and an effective amount of binder, wherein the total percentage of such ingredients add up to 100%. A novel IR tracer projectile containing such IR tracer composition for generating a dim visibility IR trace is also provided.
Development Methodology

Using « Lean Design for Six Sigma » methodology:

1. Preselection of formulation
2. Characterisation of ingredients/formulation:
   – Particle size distribution
   – Heat of combustion
   – Sensitivity to friction and static
3. Combined Design of Experiment (DOE):
   – Ingredients
   – Process parameters
4. Static firing & Spectrum Analysis
5. Long Range, Live Fire Testing
6. High Rate Production Testing
Design Of Experiment (DOE)

- 20 formulations
- 16 projectile assembly process parameters
- 320 Static test series:
  - Spectrum analysis
    - Light Intensity
    - Wavelength distribution
  - Burning duration
- Downselect to:
  - 4 original formulations
  - 2 optimized formulations, based on DOE Model
- Long range live fire night testing
- Choice of optimal formulation
Spectrum Analysis – Lab Setup

- Tracer mix placed on high speed router shaft
- Initiation of trace through friction between rotating igniter pellet and steel nail upon contact
- Spectrum recorded through Spectrophotometer

Friction initiation device, before contact

Friction initiation after contact with tracer

Spectrophotometer

Tracer Lighting Apparatus.mpg
Spectrum Analysis Example

Sodium

Emitted light intensity

Wavelength (nm)

7.62 mm
5.56 mm
Live Fire Test Results

Tests done with cartridges conditioned at -52°C, 21°C and +54°C

Minimum IR Trace distance:
- 5.56mm: 100% met 600 m objective (average = 650 m)
- 7.62mm: 100% met 775 m objective (average >1,000 m)

IR Trace very bright to side observers through Gen II NVG
- 95% + visibility all along the path

IR Trace invisible to naked eye side observer

IR Trace faintly visible to naked eye from firing position because:
- Low light level eye response shifted to shorter wavelengths at night (scotopic vision) due to rod receptors
- IR trace spectrum indicates some low light emissions in the 500 nm area
Unaided Night Vision

- Emitted light intensity vs Wavelength (nm)
- Blue curve: 7.62 mm
- Red curve: 5.56 mm
Live Fire Testing Results

Conventional 12.7 mm Igniter
1/30 s View through Image Intensifier

Dim Trace 12.7mm Igniter
1/30 s view through Image Intensifier
Flame Temperature

- Visual tracer measured flame temperatures: >1350 °C
- Maximum measured flame temperature of IR formulation: 200°C to 250 °C
High Rate Production Process Qualification

- High Rate projectile tracer loading was developed for the Manurhin MCH 240 Tracer Loading equipment.
- Same tooling as for conventional tracer was used.
- Dry ignitor and tracer mix were adjusted to ensure homogeneous flow in hoppers and feeders.
Conclusion

- Satisfactory 5.56mm and 7.62mm IR Trace formulation, clearly visible with Gen II NVG was developed.
- New formulation may be used on conventional tracer loading machinery.
- IR trace invisible to enemy combatants on receiving end with or without Gen II NVG.
- Final qualification process to be undertaken shortly.
- Samples available.
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