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SHORT COMMUNICATION

Editors Note: Beginning with this issue, the information on current R&D developments that have taken place not in DRDO laboratories but also in other laboratories working in the areas having direct applications in Defence, are also being covered in the form of short communications. Two such R&D developments, namely, Design and Fabrication of 35 GHz *GaAs* Gunn Diodes and Solid Incendiary Compositions have been included in this issue.

Solid Incendiary Compositions

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ABSTRACT

Incendiaries are chemical agents which on suitable initiation cause destructive damage due to fire on combustible targets. A solid pyrophoric incendiary composition has been developed and evaluated for its effectiveness, storage life and applications in different devices. This paper describes the method of preparation and compares the properties of the developed composition with a number of other solid incendiary compositions.

INTRODUCTION

Incendiary devices are used to initiate destructive fires for causing damage to various combustible targets, like fuel and ammunition dumps, base camps, tents, industrial installations, refineries, camouflages, wide area of grass/paddy fields. Incendiary devices can be delivered to the target end by aircraft, artillery guns or missiles in the form of bombs, shells and warheads. The tactical use of such devices is to create psychological fear of mass fires and destruction amongst troops during operations. The efficacy of the incendiary compositions to ignite combustible targets depends on factors, such as total heat output, burning temperature, duration of burning and spread area. The dispersion of incendiary composition is achieved either by bursting or by base ejection of the ammunition/shell.

In general, the incendiaries are categorised as liquid, gel and solid incendiaries (based on metal powders).

Liquid hydrocarbons, like benzene, gasoline, toluene, xylene, etc. are reported to be used through flame throwers. Other types of promising liquids for incendiary applications are triethyl aluminium (TEA), trimethyl magnesium, diethyl zinc, etc[1-3]. But their application in the armament system has not been much reported so far. In US, TEA is filled in the casings/ammunitions of small calibre shoulder-fired rockets[4]. The liquid incendiaries, however, suffer from drawbacks, such as limited storage life and poor incendiary effect, and are not suitable for spinning type projectiles.

The mechanical strength and performance of liquid incendiaries can be improved by the addition of suitable thickening/gelling agents (metal soaps, rubber and polymers). A notable development of such system was the Napalm-based incendiaries, which were found to be very effective in Korean, Vietnam and Gulf wars[4-6]. The original Napalm was a mixture of aluminium soaps (12 per cent) of naphthenic or palmitic acids with gasoline[7]. Napalm 'B' is a viscous mass obtained by mixing 50 per cent polystyrene, 25 per cent gasoline and 25 per cent benzene. It gives longer duration of burning, higher heat output and better sticking property[8]. However, these gels are suitable for non-spinning projectiles, like bombs, mortars and rockets, and have short storage life. A number of thermite incendiaries and metal powder bombs are also reported as incendiary agents (*Al*, *Mg* alloys and thermite compositions). These compositions are pyrophoric of a low order and cannot be ignited on bursting; and a separate pyrotechnic device is needed

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for ignition[9-14]. Aluminised high explosives and fuel-air-explosives (FAE) also have been claimed to be incendiary agents. These systems, on bursting, produce fireballs above the ground for a few milliseconds[6]. The advantages and disadvantages of different incendiaries are indicated in Table 1.

Table 1. Comparison of different incendiary systems

Property	Solid incendiaries	Gel/liquid incendiaries
Heat output (cal/cc)	18 100	8 000
Temperature (°C)	2 000	670
Duration of burning (s)	150	60
Stickiness	Non-sticky	Sticky
Storage life (yrs)	10	0.5
Suitability	Suitable for spinning and non-spinning projectiles	Not suitable for spinning projectiles.

In view of the numerous advantages of solid incendiary compositions for spinning-type projectiles, pyrophoric metal (*Zr/Ti*) powders-based compositions with suitable binders (natural rubber) were studied. The use of the pyrophoric metal powders facilitates the ignition of incendiary compound on bursting. The use of binder provides mechanical strength to the composition, which in turn, makes it suitable for spinning-type projectiles. This communication reports the results of various *Zr/Ti* powders-based incendiary compositions studied and developed at ERDL.

2. EXPERIMENTAL DETAILS

Zirconium powder of 98 per cent purity, received from the Yashoda Special Metals Pvt Ltd, Hyderabad and having average partical size of 5-8 micron, was used. Unvulcanised natural rubber was used as binder.

The compositions were prepared by dissolving rubber in benzene. The gel thus formed and metal powder (*Zr/Ti*) were mixed in the Sigma mixer thorougly. The mixed mass was then poured into trays and cured at 60 °C for 24 h. The cured sheet was broken into pieces, which were then consolidated into pellets of required size and geometry by pressing technique, followed by assembly of pellets in projectile casings. The compositions thus obtained were evaluated in a number of devices and subjected to static as well as dynamic tests, for their efficiency.

3. RESULTS AND DISCUSSION

The results on the incendiary effect of the compositions studied are given in Table 2. The results obtained indicate that solid incendiary composition based on *Zr* and rubber is the best in view of better pick-up and longer burning duration. Further, optimum proportion of rubber for *Zr*-based solid incendiary composition is 7 per cent to achieve optimum compromise on incendiary effect and mechanical strength. The temperature of the burning incendiary pieces, as measured using W/R_e thermocouple, was observed to be of the order of 2000 °C. The results of static trial with stimulated targets clearly indicated that the composition is capable of igniting all combustible targets. The composition studied is suitable for production, filling and application.

Table 2. Incendiary effect of various compositions

Composition (%)		Observat.	
		Spread diameter (m)	Duration of burning (min)
Zr Thermite Rubber	60 33 07	40	0.25
Zr Rubber	95 05	40	1.0
Zr Teflon	95 05	40	0.5
Zr EP 4	95 05	30	0.25
Ti (fine) Rubber	93 07	30	0.1
Zr Rubber	93 07	50	3.0

Note: 1. Weight of the compositions : 1.5 kg
2. Thermite constitutes *Al* - 25 per cent, Fe_2O_3 - 75 per cent

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