INITIATION OF ENERGETIC MATERIALS BY LASER MEANS

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Energetic materials are substances or a combination of substances which can be found in metastable states and can release heat and gasses when they are stimulated by a specific external cause. Also they can be defined as those materials with a relatively high amount of stored chemical energy (in a given volume or mass) that can be quickly released. This kind of release of energy can be slow, as it occurs in deflagrations, or very fast as it occurs in detonation. Energetic materials are a class of substances which include pyrotechnic compositions, propellants, and explosives and they are extensively used in civilian and military applications. Nowadays, there are various ways of igniting energetic materials. Some of these methods are safer than others and we can observe, as it should, a tendency of choosing those over the ones that can put our life in jeopardy, even though some of them can have more downs than ups. When we speak about the detonation of energetic materials there are two ways of doing it. On one side we can use the transition from deflagrations to detonation, and on the other side we can apply a shock wave on the surface of the energetic material.

As it was mentioned before, safety is the most important aspect when we speak about igniting different systems of ammunition. As there are more and more safety requirements imposed by the agencies around the world, it is mandatory to develop new ways, safer and also cheaper, of using pyrotechnic compositions, propellants, and explosives. Initiation of energetic materials by laser means is an advanced technology which will result in igniting ammunition subsystems in the near future. Applications of this method will be exclusively

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guided by the safety requirements which are more demanding day by day and, by the need of developing systems that are cheaper to manufacture and use.

There are several steps in initiating an energetic material by laser. In a first phase, there is no chemical reaction inside the material and it becomes an inert solid by heat transfer. After a short period of time, at a certain ignition temperature (which is relatively high) and a certain ignition time, the heat delivered by the chemical reaction is really high and that way the ignition takes place.

Insensitive explosives such as FOX-7 (1,1-diamino-2,2-dinitroethene) can be initiated by optical means in order to increase its stability to detonation, characteristic which already has high values. FOX-7, also known as DADE, is a very interesting explosive because of its low sensibility to thermal and mechanical stimulus cumulated with its extraordinary explosive performances (similar to the ones of RDX). These kinds of features are the ones which recommend the usage of FOX-7 in modern insensitive munitions. In order to increase DADE's sensibility to laser radiation, an optical sensitizer is required. Because of its great energy absorbing characteristics, small particles of CB (carbon black) are incorporated in the explosive's mass.

In the last years, the process of initiating energetic materials by optical means has been receiving much attention. There were established mathematical models and experimental investigation were conducted, in order to better understand the basic operations involved in the process. All of those leaded to the idea that the formations of so-called "hot spots" are responsible for the initiation of energetic materials by laser means. The studies conducted for the last four decades revealed the fact that also the pyrotechnic compositions and the primary explosives could be initiated using lasers which emit radiation in the UV-VIS area. This theory is based on the idea that those kind of energetic materials have their absorption bands situated in the UV-VIS area. As it was mentioned before, if a laser which emits in the IR area is used, it is needed to optically sensitize the explosive using materials capable of absorbing the infrared radiation, such as carbon black. In the particular case of FOX-7, it only takes a 15 minutes tumble mixing of those two components (DADE and CB) in order to obtain an energetic material which can be initiated by optical means without affecting its explosive performances.

Because the initiation of energetic materials by optical means has reached a certain level of maturity lately, it is just a matter of time until the detonators operable by laser will take an important place in both military and civil applications around the globe. Initiation by a radiant and precise beam is offering some advantages when compared with the traditional ways of initiating energetic materials. Above them it can be mentioned the fact that the risk of accidental igniting caused by the electromagnetic fields and electrostatic discharge is eliminated. Also the process of testing the integrity of the igniting system can be conducted without affecting the safety or the reliability of the whole system. Even though the beam can be easily focused and also its deviation caused by air is insignificant, this method of initiating energetic materials has the disadvantage that the energy which forms the beam has a heterogeneous distribution.

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