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(54) **Anaerobic sealing of the interfaces between ammunition parts.**

(57) Anaerobic sealing is used on the interfaces between ammunition parts, e.g. of initiators, squibs, detonators, actuators, primers or other pyrotechnic devices and explosive devices. Said interfaces can comprise metal to metal, metal to non-metal or non-metal to non-metal interfaces between for example sleeve and plug, chamber and housing, insulator and sleeve or electrical structures and insulators. Said anaerobic sealing can comprise acrylate sealant.
Cited trademarks: Loctite; Flexseal.

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Background

The present invention is directed to a means of sealing the interfaces in energetic devices with anaerobic sealants. Anaerobic seals for interfaces between like-to-like materials or dissimilar-to-dissimilar materials in assembled devices such as squibs, detonators, mechanical actuators, initiators, and primers are found easier to produce commercially and equivalent in service to present seals.

The present technology is aware that interfacial seals between like materials and interfacial seals between dissimilar materials remains a problem in the energetic devices art. Welding and soldering techniques are considered the benchmark technology which is known to this art and provide substantial means for sealing the troubled interfaces that concern the present invention. These techniques, however, do not easily lend themselves to the rigors of commercial production. Chemical sealant techniques have been used to seal interfaces, for example in U.S. patent 3,971,320, incorporated herein by reference in its entirety, potting materials such as epoxy resins are disclosed to seal the interfaces of squibs to insure environmentally tight seals.

Energetic devices comprise a generic group of assembled structures that require a chamber which provides a common reaction forum thus enabling explosive compositions to react. For reliable reactions, the chamber and its companion structural interfaces must be sealed against the ingress of moisture and other contaminants often found in the hostile environments in which these devices must function. Anaerobic sealing techniques are generally known to those skilled in the explosive ordnance art such as that used with percussion primers.

The present invention is directed to the use of anaerobic sealing techniques for interfaces in energetic devices. Such use is heretofore unknown for these devices and give significant manufacturing advantages, such as ease of sealing these surfaces in a fast and economic manner, thus reducing production costs. Additionally, means may be added to the anaerobic sealing technique to facilitate quality assurance, an important aspect of any energetic device manufacturing process. As those skilled in this art appreciate, once manufactured it is difficult to determine sealant presence at the interfaces, the present invention lends itself to such a determination.

The present invention is useful for all manner of sealing interfaces in energetic devices, this is especially useful in the automotive airbag business in the production of initiators.

SUMMARY OF THE INVENTION

A single or plurality of interfaces between components in energetic devices comprising an anaerobic sealing means wherein said means communicates therebetween and therefrom metal-to-metal first surfaces, metal-to-nonmetal second surfaces, and/or nonmetal-to-nonmetal third surfaces wherein said first, second, and/or third surfaces are optionally a part thereof and therein of said energetic devices. The single or plurality of interfaces can be any of the surfaces brought together of the assembled pieces or components for the manufacture of energetic devices. In particular and by way of example, the interfaces between metal sleeves either first or second side said first side juxtaposed to a plug assembly, said plug assembly a closure means which enables a signal transmission such as light, by way of example a laser, electrical or mechanical stimulation for said signalling purposes, a metal cup or chamber means that fit juxtaposed to a housing and/or to said first side of said sleeve, the insulator materials that fit juxtaposed or within said second side of said sleeve or chamber means, component electrical structures embedded within said insulators, and the dissimilar interfaces of the body used to cap the top portion of an energetic device such as a squib. The three different interfaces are optional in the sense that not all three are required in any one device, although, of course, at least one of the options must be in the device.

The energetic devices of particular benefit to the present invention are squibs, initiators, mechanical actuators, detonators, primers, pyrotechnic devices, explosive devices, combinations thereof and therebetween. Preferably squibs, initiators, and mechanical actuators, most preferably squibs and initiators are the beneficiaries of the present invention.

The metal-to-metal interfaces commonly used in energetic devices may be selected from the first, second or third transition series, alloys thereof and combinations thereof from the Periodic Chart. Preferably, aluminum, copper, carbon steel, stainless steel, iron, zinc, nickel, tin, titanium, alloys and combinations thereof, most preferably aluminum, copper, stainless steel, alloys, combinations thereof and therebetween. The metal-to-metal interfaces may be combinations of either the same metal interfaces or dissimilar metal interfaces.

The metal-to-nonmetal interfaces include all of the metals recited hereinabove, and nonmetal materials comprising, glasses, ceramics, glass-ceramics, insulators such as thermoplastic and thermosetting materials and blends thereof. Examples of glasses are soda-lime silicate, borosilicate, quartz, aluminosilicate, mixtures of alkali and alkaline earth silicates, ferrosilicates. Ceramic materials such as borates, zirconates, aluminates, lanthanates, titanates, and combinations thereof are used as insulators. Thermoplastics such as the nylons, (Nylon 66 and 6, for example), polypropylenes, polystyrenes, ABS, polyesters, polyethersufones (PES), polyetherethersulfones (PEES), polyetheretherketones (PEEK), polyetherketones (PEK), polyetherimides (PEI), polycarbonates, polyvinyls, polyacetates, acetals, polyethylenes, and combinations thereof. Thermosetting materials such as epoxies, methacrylates, acrylics, cyanates, isocyanates, phenolics, phthalates, and combinations thereof. The above recited nonmetals may be sealed with other nonmetals as recited above in any combination using the same sealant techniques disclosed herein.

Communication may be defined as its ordinary meaning indicating that through and as a result of the anaerobic sealant means, the interfaces are brought together forming a combined unitary functional assembly that is environmentally stable to, by way of example, moisture, solvents, electrical charges, pressure and temperature variations. The anaerobic sealant means has been found to withstand the same environmental stresses as the welding and soldering techniques resulting in equivalent interfacial seal integrity.

The anaerobic sealant, such as Loctite 290 (obtained from the Loctite Corporation, Newington, Connecticut) the preferred sealant, for sealing metal-to-metal interfaces, applies through a wicking action after the assembly has been combined. Of course, application may be applied prior to assembly, however, it is preferred for purposes of commercial production, to wick the sealant to, through, between, and/or on the interfaces after assembly. Due to its lower viscosity (as compared to the soldering and welding techniques), the anaerobic sealant runs into and thereafter remains on and between the interfaces. It is believed that the interfacial surface energies may be relaxed by sealant presence thereon and therebetween said interfaces, thereby enabling the above-referenced communication.

An important consideration in this sealant technique is the methodology of its application, touched on hereinabove. The production method most familiar to those in this art are the solder and/or welding techniques. These techniques employ before-assembly and/or after-assembly methods which decrease the economies available to mass production assembly that after-assembly methods using anaerobic sealants promote. Due to the wicking and solvent characteristics of these anaerobic sealants an ultraviolet reflecting or absorbing means may be mixed with the sealant. Thereafter, an ultraviolet detection means may be employed on-line in a production line to quality check and thus assure that the sealant found its way to the interface, in fact. The solder and welding techniques do not lend themselves to such a sophisticated detection means, requiring an operator assisted observation. The economies therefrom of the present invention reduce labor intensity, increase speed of assembly, increase reliability of product quality and assurance thereof, and the economies that flow therefrom.

For sealing metal-to-nonmetal interfaces Flexseal XT, (obtained from the Loctite Corporation, Newington, Connecticut) is the preferred sealant. This sealant is applied in a dry vacuum environment whereby the assembly is introduced into a vacuum chamber with sealant, the partial pressure of air above the sealant removed, then the sealant is impregnated into the assembly under pressure. Similar equivalency in sealed interfaces with ease of manufacture is experienced with this sealant, as well. It has also been conveniently found that wet vacuum and/or pressure techniques may be utilized for operational species, as well, dependent upon manufacturing requirements.

Other anaerobic sealants contemplated as operable hereunder are derived from the family of anaerobic sealants which may include thermosetting sealants and the generic acrylates which are not necessarily completely anaerobic in their curing properties and may include thermally and/or ultraviolet (UV) initiated polymerized sealants.

Anaerobicity, even if only partial, is an important part of this sealant mechanism since oxygen curing of the sealant may be an impractical and therefore not preferred, although operable, means of curing within the interfaces.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

By way of example of how the above recited invention may be practiced, the following description is offered, not intending to limit the scope thereof.

Three hundred squid energetic devices were prepared wherein 100 of each squib were prepared whereby the chamber means was inserted into the housing means and mechanically crimped by a 360 degrees perimeter crimp. Said crimp was positioned such that the housing means and chamber means were crimped simultaneously and therefore together. A similar sample subset was crimped and sealed with solder, and a third subset was crimped and sealed with the anaerobic sealant, Loctite 290. The samples were then subjected to an accelerated environmental test where for a thirty-six week time period the squibs from each subset were subjected to a humidity chamber at 25 to 60 degrees centigrade cycling over a 24 hour period.

Each squib assembly was placed in a pressure/time test bomb. The squib is initiated and the time from application of firing current to peak output pressure was measured. This test provides a measure of moisture contamination. The more moisture ingress into the sample the longer the test times. This test is known by those skilled in the art as MIL-STD-810C, Method 507.1. The squib assembly which is the subject of the present invention, is the same assembly as disclosed in U.S. patent 3,971,320, the structure and description of which are incorporated herein by reference in its entirety.

The crimped only subset exhibited multiple failure modes whereas the solder and anaerobic sealant subsets performed equally well with no failures for either method and no substantial degradation.

Claims

1. A single or plurality of interfaces between components in energetic devices comprising an anaerobic sealing means wherein said means enables communication therebetween and therefrom metal-to-metal first surfaces, metal-to-nonmetal second surfaces, and/or nonmetal-to-nonmetal third surfaces wherein said first, second, and/or third surfaces are optionally a part thereof and therein of said energetic devices.

2. The interfaces of claim 1 wherein said interface between components comprise a sleeve and a plug assembly .

3. The interfaces of claim 1 wherein said interface between components comprise a chamber and a housing.

4. The interfaces of claim 1 wherein said interface between components comprise insulator materials and sleeve.

5. The interfaces of claim 1 wherein said interface between components comprise electrical structures and insulators.

6. The interfaces of claim 1 wherein said interface between components are combined to form a squib.

7. The interfaces of claim 1 wherein said interface between components are combined to form an initiator.

8. The interfaces of claim 1 wherein said interface between components comprise metals selected from the group consisting of aluminum, copper, stainless steels, alloys thereof, and combinations thereof and therebetween.

9. The interfaces of claim 1 wherein said interface between components comprise nonmetals selected from the group consisting of glasses, ceramics, glass-ceramics, thermoplastics, thermosets, and combinations thereof and therebetween.

10. The interfaces of claim 1 wherein said communication provides a unitary assembly.

11. The interfaces of claim 1 wherein said anaerobic sealant is Loctite 290.

12. The interfaces of claim 1 wherein said anaerobic sealant is Flexseal XT.

13. The interfaces of claim 1 wherein said anaerobic sealant is a wicking sealant.

14. The interfaces of claim 1 wherein said anaerobic sealant is combined with a detection means to provide on-line quality assurance.

15. The interfaces of claim 1 wherein said sealant consists of an acrylate.

16. The interfaces of claim 1 wherein said sealant is thermosetting.

17. The anaerobic sealant of claim 1 wherein said sealant is partially anaerobic.

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EUROPEAN SEARCH REPORT

Application Number
EP 94 30 3878

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
X	GB-A-1 345 939 (LOCTITE CORP.) * page 1, line 33 - line 81 * * page 5, line 1 - line 10 * * page 7, line 5 - line 57 * ---	1-17	F42B3/11 F42C19/00
X	US-A-4 661 190 (GELINAS ET AL.) * column 1, line 13 - line 21 * * column 1, line 45 - line 56 * * figures 2,3 * ---	1-17	
X	DE-A-36 22 124 (INTEGRAL HYDRAULIK & CO.) * column 4, line 30 - line 42; figure 2 * ---	1-17	
A	DE-A-25 56 179 (HAGENUK & CO.) * page 5, line 23 - page 6, line 2; figure 1 * ---	1-10	
A,D	US-A-3 971 320 (LEE) -----		
			TECHNICAL FIELDS SEARCHED (Int.Cl.5)
			F42B F42C F42D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	14 September 1994	Giesen, M

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
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