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ENCAPSULATION OF EXPLOSIVE PARTICLES BY PARYLENE

Jacob Sandoval

DEVELOPMENT DIVISION

OCTOBER - DECEMBER 1971

Normal Process Development
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MASTER

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DISCLAIMER

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The objective of this investigation is to evaluate the feasibility and merit of encapsulating HE particles and other materials and components used in explosive systems.

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Section P

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DISCUSSION

Parylene is the generic name for members, e.g. parylene N,C,D, of a thermoplastic polymer series developed by Union Carbide ("Reta" is a trade name for the materials). All of the members are laid down by a vacuum, vapor deposition process.

The properties and uses for each member of the series differ from each other, but collectively the Parylenes have a wide range of applications.

The Parylenes are deposited on any substrate maintained in a deposition chamber, providing the following conditions are met:

1. The substrate must be able to withstand vacuum.
2. The substrate should not react chemically with the polymer.

There are probably other conditions, e.g. having to do with particle size distribution. The actual coating process is promoted at ambient temperature.

Union Carbide lists many uses for the Parylenes. The following applications are listed in Union Carbide (bulletin), Chemical and Plastics Physical Properties, 1970 Edition, p. 56:

> *Parylene is highly recommended for use as a true conformal dielectric coating because of its (1) ability to be deposited as an ultrathin, continuous, uniform adherent coating and (2) its outstanding electrical and barrier properties.*
>
> *Such coatings as thin as 0.001 mil or as thick as 2 mils can be deposited on discrete electronic components: resistors, thermistors, semiconductors, integrated circuits, and electroluminescent displays.*
>
> *Other suggested applications:*
>
> *Parylene coating to protect memory disks, ferrite cores, stator cores and fast-responding probes such as thermistors and thermocouples.*
>
> *Military standards:*
>
> *Parylene meets all of the military standards required for conformal coatings for circuit boards in thicknesses of 0.5 to 2 mils. Parylene polymers are proven passivating agents for semi-conductor devices, and they offer photoresist characteristics when used as a thin film.*
>
> *Other applications include:*
>
> *Parylene coating to encapsulate highly reactive particulate protection from hostile environments.*

Pinhole-free Parylene pellicles (membranes) can be deposited in thicknesses from 0.1 to 2 microns for use in optical and radiation applications and as a thin film dielectric support.

Gas permeability and moisture vapor transmission of Parylene C are very low. These properties make Parylene potentially very useful with or near explosives or components. One of the forms, Parylene C—the monomer of dichloro-di-p-xylylene—is potentially attractive. Its density is 1.29 g/cc.

In this study the initial emphasis will be on the feasibility of coating HE particles. Substrates of diminishing particle size will be encapsulated to establish the particle-size limitation of the process.

Any substrate, meeting the requirements listed earlier, may be encapsulated provided it can be accommodated in the deposition chamber. The equipment can be modified or scaled-up to meet the requirements and configuration of the items to be embodied.

There is interest in the encapsulation capabilities in several areas. Along with HE particles and shaped charges, encapsulation or coating of bridgewires, coaxial pins, ionization pins and other components have been requested.

The 2-inch Reta Vapor Coating Unit and the large scaled-up Vacuum Deposition Unit have been delivered and are housed in Building 11-38, Bay 3, where they will be assembled and operated.

The 2-inch Reta Vapor Coating Unit was stripped when procured (it had been used by USAF and Union Carbide); however, all essential components to make the unit operational are on hand.

FUTURE WORK; COMMENTS; CONCLUSIONS

The initiation of the study on the feasibility of encapsulation of HE particles awaits the assembly of the 2-inch Reta Vapor Coating Unit. The large Scaled-Up Vacuum Deposition equipment will be put into operation at a later date.

A short orientation period will be required to familiarize the personnel with the equipment and the techniques to be employed.

To preclude any unsafe incident, during the familiarization period, the following precautions have been established:

1. *Personnel will encapsulate only inert substrates during the orientation period.*

2. *Glass beads (3mm dia) will be coated first. These will be immersed in hydrofluoric acid to check the film efficiency. Since Parylene is unaffected by acids, no etching of the beads should result.*

3. *Prilled ammonium nitrate will be coated. The coated particles will be submerged in water, and the pH of the water recorded for a period of time.*

4. *As personnel gain experience and proficiency the endeavor will progress to the encapsulation of explosive particles.*