Conformal Coating Relevance a National Security Interest

Focus

The focus of this paper is to provide an understanding of Conformal Coating and Potting/Encapsulation application as it relates to surface treatment and environmental protection of electronic components, subsystems and top assembly operating systems. ***Conformal Coating and Encapsulation are critical to the operational effectiveness and MTBF of electronic and electromechanical systems.***

A Brief Description

Post World War 2 the United States military moved to an operational platform based in electronic warfare. The primary objective was and remains to create a sophisticated network of communication that can see, hear, process and respond over long distances regardless of environmental conditions whether natural or man-made.

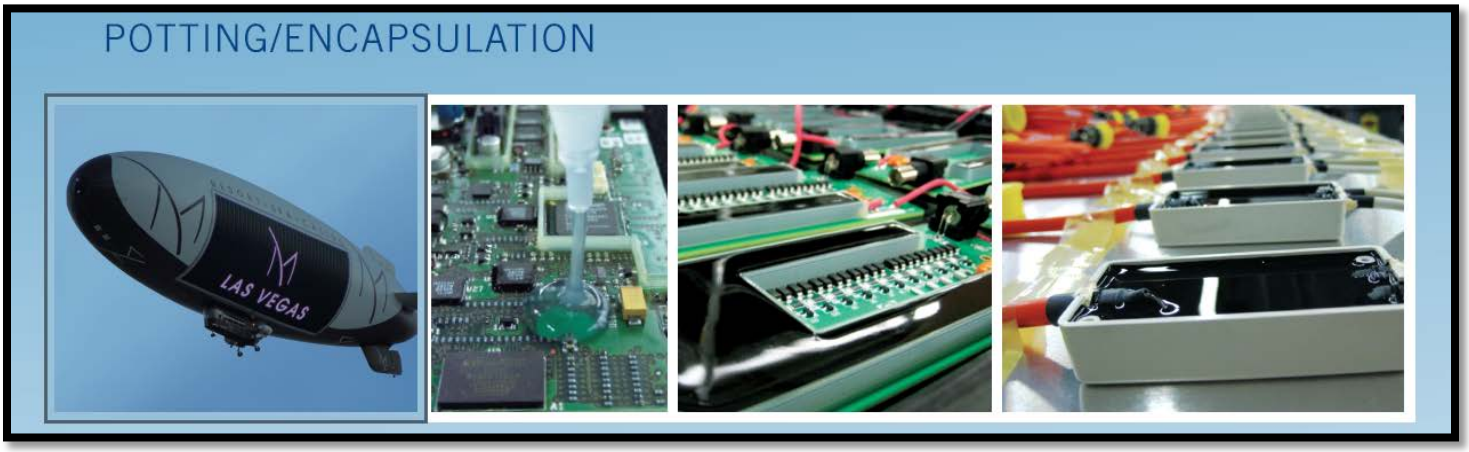
To achieve this auspicious undertaking major capital investments were (and continue to be made) in radio, radar, and satellite technologies that are linked through land, air, sea and space. It is absolutely imperative that these systems are operational 24/7/365 and in the 21st century are networked across our security services so as to optimize strategic and tactical asset deployment in the field.

During the last 20 years the U.S. military has been tasked with being capable of fighting and winning on multiple fronts against both state and asymmetric threats. These conflicts are almost always prosecuted in harsh environmental conditions that feature salt, fog, sand, wind, rain and extreme temperature changes. Corrosion is probably the number one environmental threat that electronic systems (and mechanical systems for that matter) face. To insure operational performance and long (MTBF) life it is absolutely critical that the PCB's at the heart of any EW system are conformally coated.

Conformal coatings can come in a range of chemical systems designed for all types of environmental threats. For corrosion environments a coating system that features a combination of Plasma Treatment, Parylene and Polyurethane is most effective at creating an environmental barrier against temperature and corrosion threats. This particular material system is extremely light weight and is excellent for aircraft or other assets where weight may be a sensitive factor. It also presents an extremely formidable defense against Tin Whisker growth.

If weight is not a major consideration than certain epoxy based materials can be introduced that present exceptional barriers against all types of environmental threats. In many cases the epoxy compound may feature heat dissipative fillers and depending on the chemistry of the epoxy can be "tuned" to provide EMI/RFI shielding.

Epoxies such as Kryptos-17 have been developed for environments where electronic systems have to operate in extreme temperature (-65C to +200C) ranges. This type of encapsulation system is capable of being molded into a part or component usually at weights far less than aluminum or steel. Yet featuring a durometer hardness north of 92D!



The main takeaway here is it is inconceivable to spend millions if not billions of dollars on EW systems and advanced technology platforms and for a few hundred dollars or less resist the critical engineering concept of coating, encapsulating or otherwise ruggedizing an EW device to insure reliable performance and a long operational life. Given that the security services of the United States have moved to COTS electronic components with RoHS compliance it is now an imperative that the PCB's be coated/hardened to insure electrical attachment and survivability in theater.

The Coating Process, Material Choices, Engineering and Production Services

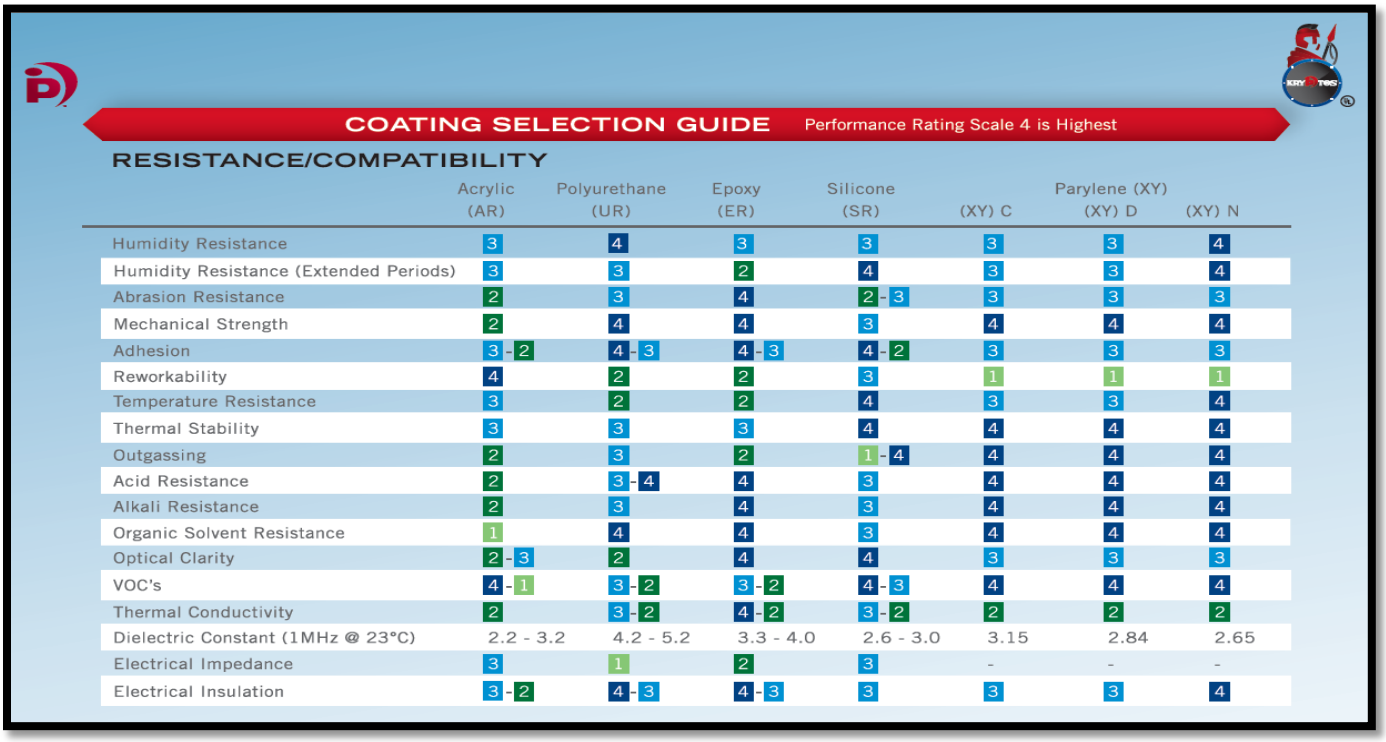
In order to properly coat or encapsulate a target, whether it be electronic or mechanical, the target must be clean and free of any FOD or contaminates that may impede the coating (once applied) from proper adhesion or could result in latent degradation of the system. To insure proper adhesion Plasma Ruggedized Solutions employs proprietary multi step cleaning processes that include a vacuum Plasma treatment process (see PRS White Paper on Plasma Technology). Once a target has been subjected to these processes it is then inspected prior to masking and the coating application is affected.

Plasma Ruggedized Solutions

Global Provider of Custom Ruggedized Engineering Solutions

AS9100C Certified

Coating material choices are largely dependent on the user's application and system needs. For military and medical products PRS recommends the use of Parylene or sophisticated versions of silicone and polyurethane. These three materials offer superior performance in all types of environments and with the exception of Parylene may be applied using various techniques and instruments. Acrylic coatings may also be quite effective but they generally do not offer the superior attributes of Parylene, Polyurethane and Silicone.



COATING SELECTION GUIDE Performance Rating Scale 4 is Highest

RESISTANCE/COMPATIBILITY

	Acrylic (AR)	Polyurethane (UR)	Epoxy (ER)	Silicone (SR)	Parylene (XY) (XY) C	(XY) D	(XY) N
Humidity Resistance	3	4	3	3	3	3	4
Humidity Resistance (Extended Periods)	3	3	2	4	3	3	4
Abrasion Resistance	2	3	4	2-3	3	3	3
Mechanical Strength	2	4	4	3	4	4	4
Adhesion	3-2	4-3	4-3	4-2	3	3	3
Reworkability	4	2	2	3	1	1	1
Temperature Resistance	3	2	2	4	3	3	4
Thermal Stability	3	3	3	4	4	4	4
Outgassing	2	3	2	1-4	4	4	4
Acid Resistance	2	3-4	4	3	4	4	4
Alkali Resistance	2	3	4	3	4	4	4
Organic Solvent Resistance	1	4	4	3	4	4	4
Optical Clarity	2-3	2	4	4	3	3	3
VOC's	4-1	3-2	3-2	4-3	4	4	4
Thermal Conductivity	2	3-2	4-2	3-2	2	2	2
Dielectric Constant (1MHz @ 23°C)	2.2 - 3.2	4.2 - 5.2	3.3 - 4.0	2.6 - 3.0	3.15	2.84	2.65
Electrical Impedance	3	1	2	3	-	-	-
Electrical Insulation	3-2	4-3	4-3	3	3	3	4

Plasma Ruggedized Solutions is the only conformal coating operation in North America and probably the world that offers more 2,500 different types of coating and encapsulation materials to choose from and possesses the engineering expertise and assets to apply the materials correctly. Additionally Plasma offers 3D printing and robotic dispensing that affords our customers unique masking capabilities through the creation of "silicone fences" creating "keep out areas" so that a specific region of the target is tightly segregated for its localized coating or encapsulation procedure.

As part of its engineering services, PRS offers Tin Whisker mitigation solutions, EMI/RFI shielding and Federal Information Processing Standards (FIPS) security services. Effectively PRS is a "turnkey" product operation and given the depth of knowledge and experience in engineering and program management we can offer complete managerial oversight of product development through the production cycle for component, subsystem and in certain instances full system level integration. PRS's production services are state-of-the art and capable of processing more than 80,000 PCB's a month (this does not include total capacity for mechanical integration, test, repair and overhaul).

From an R&O standpoint PRS features equipment and technologies to remove all types of conformal coating materials (including Parylene). Our proprietary processes include Plasma, Crystal Mark (micro-abrasion) equipment and Chemical stripping agents.

In this whitepaper we touched on the virtues of Conformal Coatings and its importance to National Security. While most of the commentary above addressed applications relating to printed circuit boards and electronic componentry, PRS's technology applications are quite useful with mechanical components and large material bodies that are in constant contact with the sea.

The PRS technical team stands ready to support our customer's unique and environmentally challenging needs. Please contact us directly at www.plasmarugged.com.