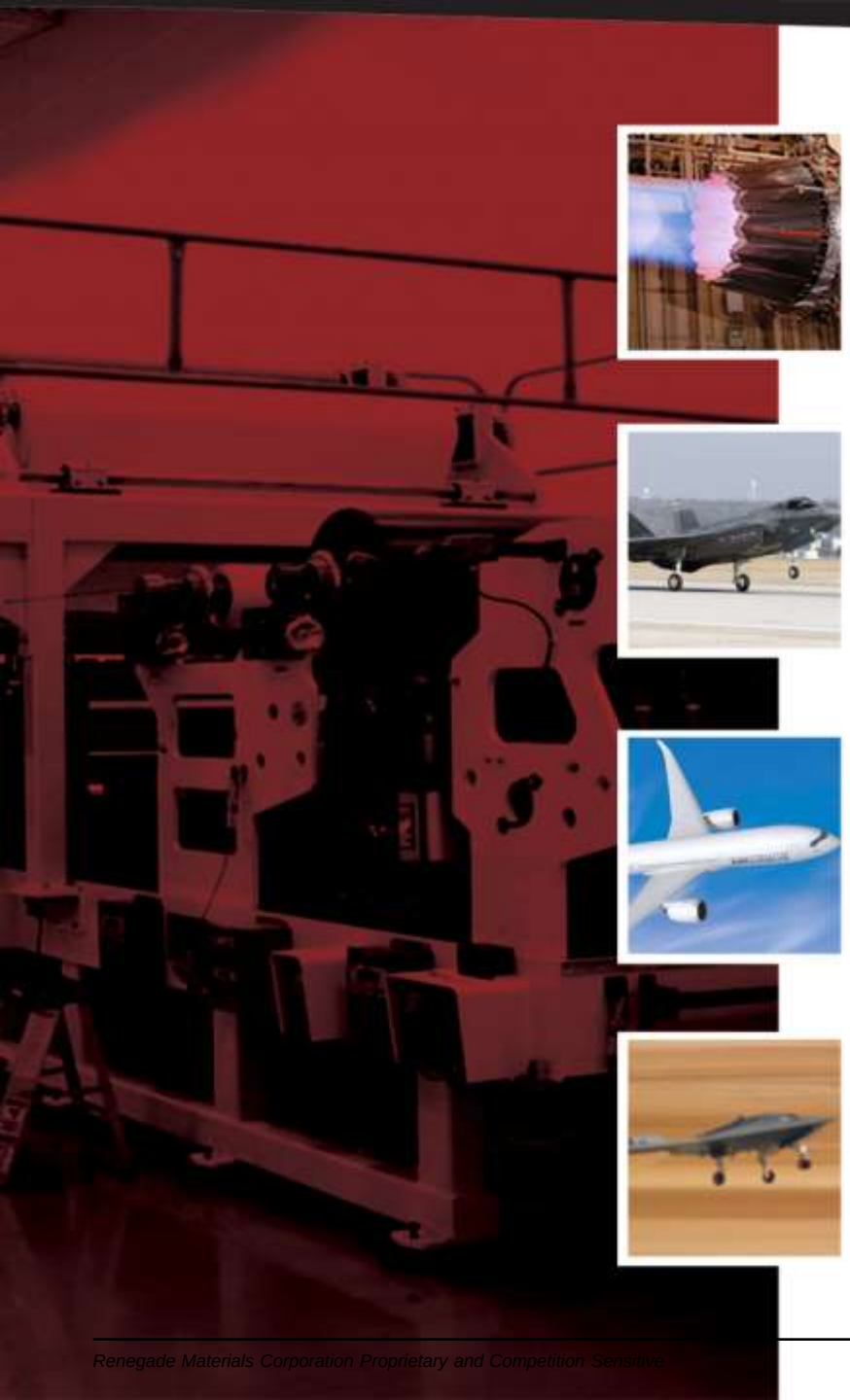

RENEGADE MATERIALS CORPORATION

Advancements in BMI's and Polyimides

UAMMI Crosstalk
March 21, 2018

Kory Abbitt
Director - Business Development
(kabbitt@renegadematerials.com)

Presentation Overview

- Renegade Materials Profile
- Overview of Renegade Materials' BMI Product Line
- RM-3004 Out of Autoclave Curable BMI
- Overview of Renegade Materials' Polyimide Product Line
- RM-1100 700°F Service Polyimide
- MVK-14M 550°F Service Polyimide

Renegade Materials Profile

- Small Business - Privately Held – Strong Financial Backing
- 40+ Employees, located in Miamisburg (Dayton) OH
- Celebrating 10 years in business this year.
- Manufacture Prepregs, Resins and Adhesives
- Led by 30+ Year Aerospace Composite Veterans
- 26,000 SF facility + additional 40,000 SF under construction

Renegade Materials Profile (cont'd)

- Renegade Materials' Designed Equipment.
- In-Line Process Controls – Lot to Lot Repeatability.
- All formulations developed within the last 10 years.
- All Materials are Green, Non-Toxic.
- Respected High-Temperature Technology Experts.
- **AS9100 Rev D** and ISO9001 Certified Quality System.
- **Nadcap Accredited -** Composite Materials Manufacturing and Testing.

Renegade Materials Product Forms

- Polyimide & Bismaleimide:
  - Prepregs
  - Adhesives
  - Infusion Resins
- Polyimide resins are developed and supplied by Maverick Corp.
- All other resins are developed and manufactured at Renegade.
- Fabric Prepreg Up to 60-inches Wide.
- Carbon, S2-Glass, Quartz and Other Fibers.
- FAW Ranges From 10 to 1,500 gsm.

Renegade Materials' Key Customers

- Boeing
- Airbus
- GE Aviation
- Honeywell Aerospace
- Northrop Grumman
- Orbital ATK
- Pratt & Whitney
- Raytheon
- Rolls Royce
- SAFRAN

- Applied Composites Eng'ring
- Aurora Flight Sciences
- Composites Horizons
- Comtek
- CTL Aerospace
- Encore Composites
- General Dynamics-ATP
- Janicki Industries
- Meggitt Aerospace

- US Air Force
- US Navy

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Bismaleimide Products

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Bismaleimide Product Line

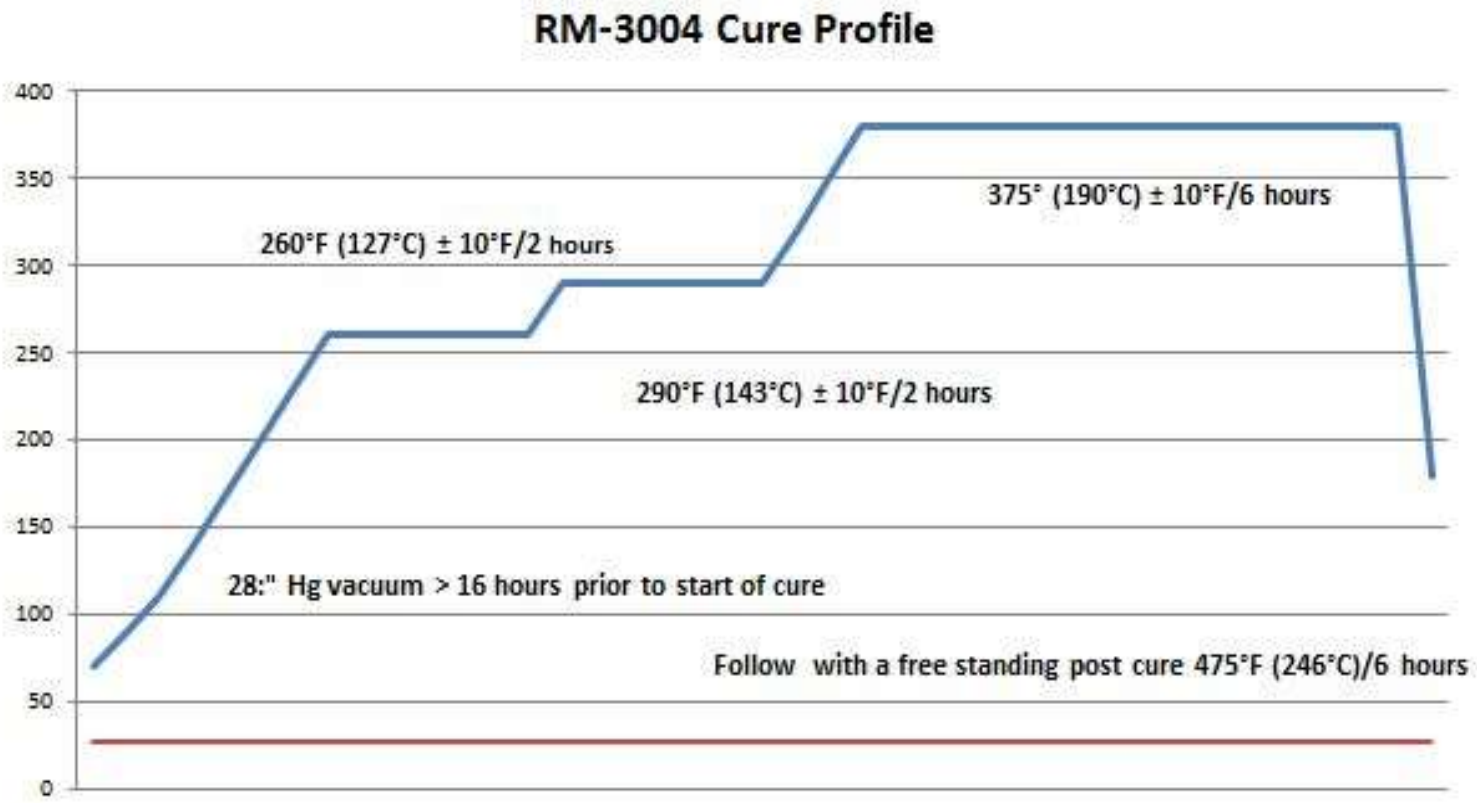
- **RM-3002** – Autoclave Cure BMI Prepreg System
- **RM-3004** – Out of Autoclave Cure BMI Prepreg System
- **RM-3000** – BMI (One Part) RTM Resin
- **RM-3010** – BMI (One Part) VARTM Resin
- **RM-3006** – BMI (One Part) Paste Adhesive
- **RM-3007** – BMI (One Part) Hole Filler Paste
- **RM-3011** – BMI Film Adhesive

RM-3004 - Out of Autoclave BMI

- Mechanical Performance Comparable to Autoclave Cure Systems.
- Impregnation Level Low to Allow Path for Voids and Vols to Escape.
- Available as Fabric Prepreg Only.
- Excellent Surface Finish.

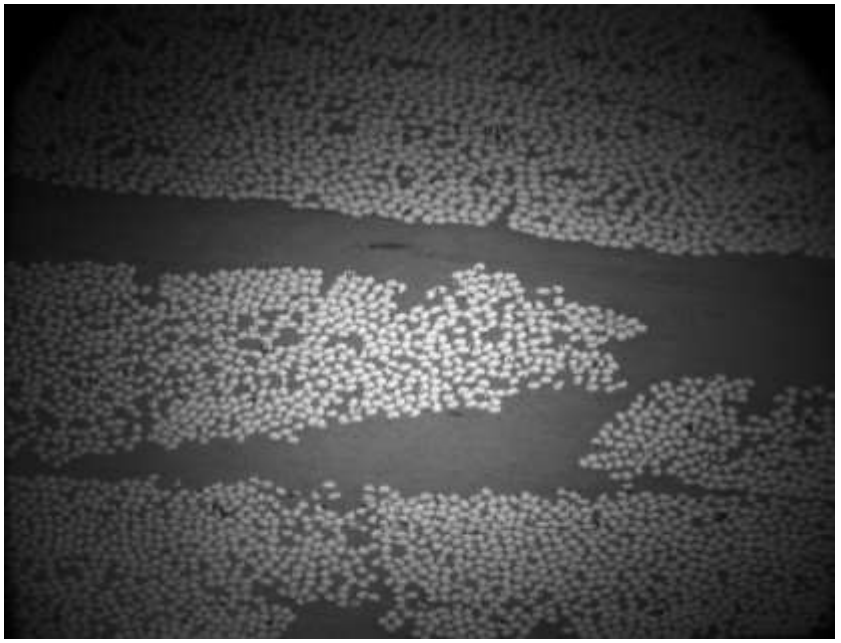
RM-3004 - Out of Autoclave BMI

- Edge bleed only bagging scheme.
- Step Cure to 350°F or 375°F; Free Standing Post Cure at 400-475°F.



RM-3004 Out of Autoclave BMI

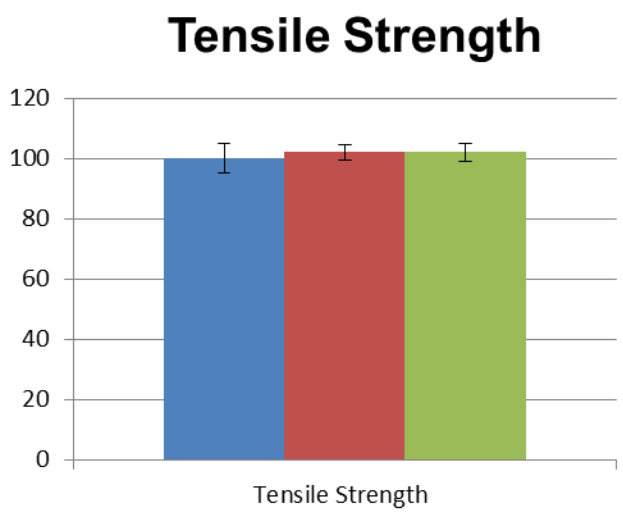
- Demonstrated on Large (>200’ Long) and Thick (up to 1.2”) Panels.
- No Micro-Cracking after 200 Thermal Cycles. (RT to 350°F).
- Excellent Tack/Handle-ability.
- Glass Transition Temperature 530°F (277°C)

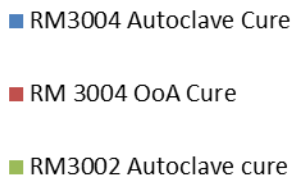


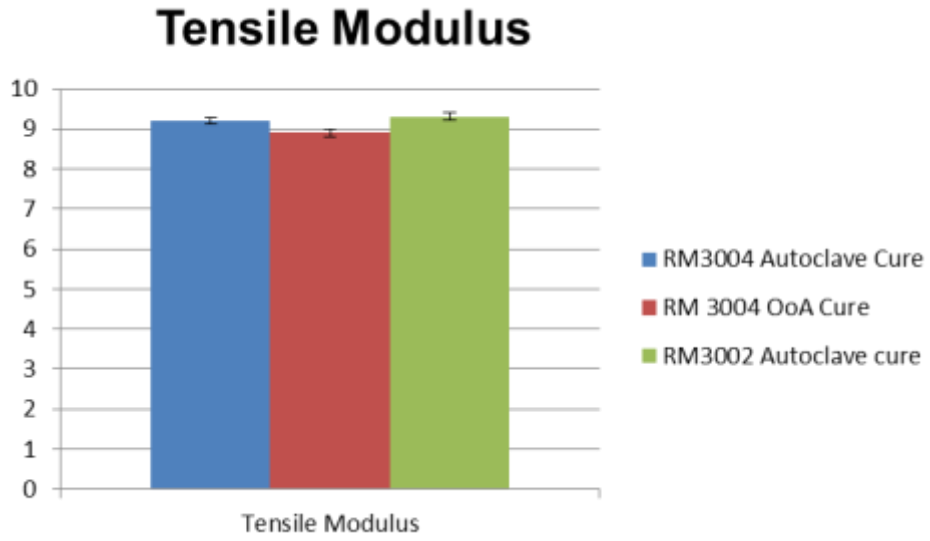
200X Photomicrograph after 200 Hrs of TC’s

RM-3004 Tensile Properties

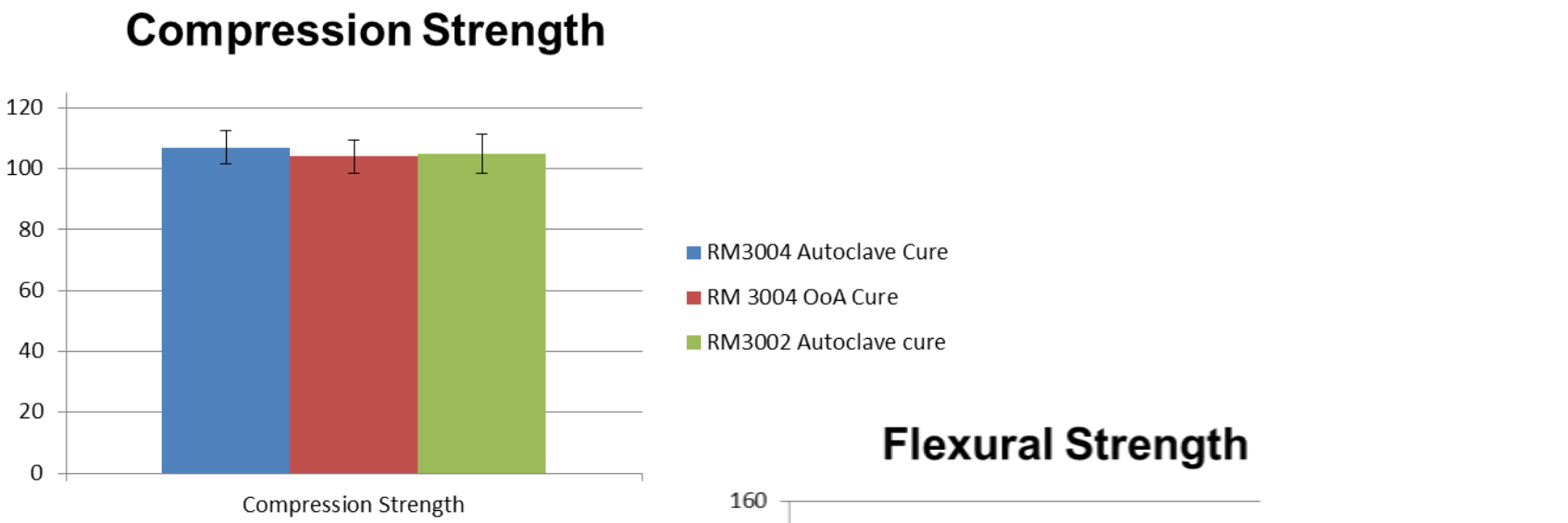
On 6K 2X2 Twill Fabric
Laminate Fiber Volumes - 55%

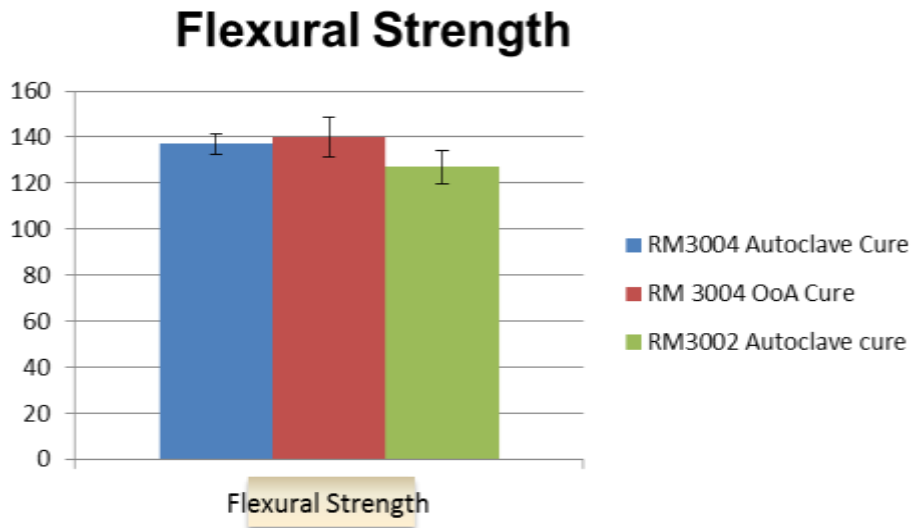






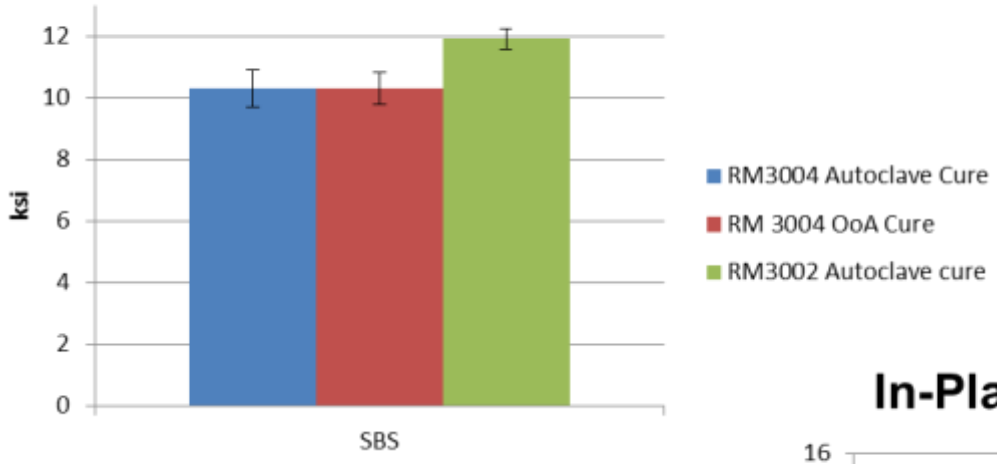
RM-3004 Compression & Flexural Properties



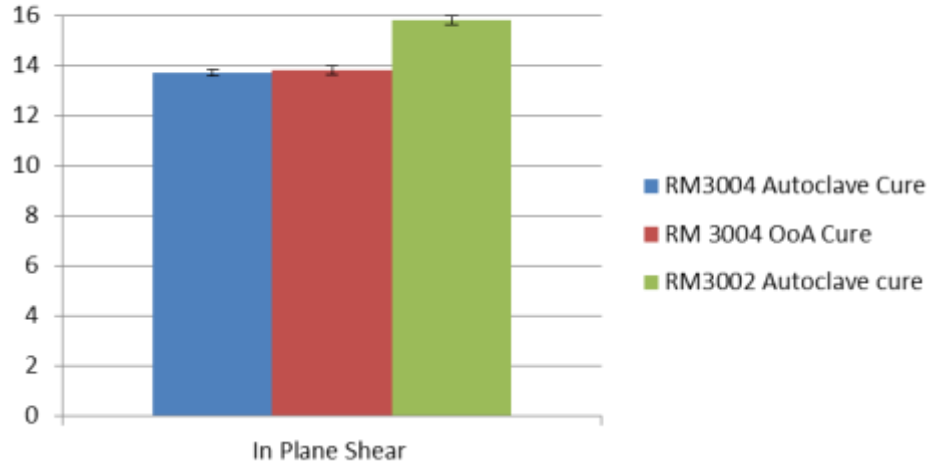


RM-3004 Shear Properties

Short Beam Shear, ASTM D 2344



In-Plane Shear ASTM D 3518



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Polyimide Products

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Summary of Polyimide Prepregs

Property	AFR-PE-4 Polyimide Carbon	RM-1100 Polyimide Carbon	MVK-14M Polyimide Carbon	RM-1066 Low-Cost Polyimide
Tg: Dry/Wet via DMA	725°F / 525°F	725°F / 568°F	590°F / 475°F	680°F
Thermal Oxidative Stability 600F, 150-psia, 125-hours	< 2%	<2%	< 2%	N/A
Design Database Available	TechMat	TBD	NCAMP & GE F136	Non-Structural Skybond Replacement
ITAR or Export Control	ITAR	Export	Export	Export
Cure/Post Cure Temp	700°F	700°F	600°F / 600°F	350°F / 700°F

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RM-1100 Polyimide Prepreg

- Non-ITAR; Export Approved
- Available as fabric and unitape prepreg.
- Superior to AFR-PE-4 in temperature performance and process-ability.
- Service to 700°F
- Selected as Non-Carcinogenic Replacement for PMR-15 in Military and Commercial Engines and Aircraft Structures.

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MVK-14M FreeForm® Polyimide

- Developed & Patented in 2006 for Engine Ducts, Splitters & Inlets.
- Non-ITAR; Export Approved
- Available as Fabric and Unitape Prepreg.
- Service to 550°F
- Affordable, Non-Carcinogenic Replacement for PMR-15.
- NCAMP B-Basis Allowables Funded by the Air Force.
- NCAMP Specification NMS141

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Summary of Polyimide Adhesives

Film Adhesive	Paste Adhesive	For Use With…	Cure Temperature	Service Temperature
RM-1005	RM-1005-PASTE	AFR-PE-4	350-400°F	≤650°F
RM-1014	RM-1014-PASTE	MVK-14	550-600°F	≤550°F
RM-1010	RM-1010-PASTE	RM-1100	600-700°F	≤650°F

*** PRIMER solutions available for use with all film/paste adhesives.**

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Thank you for your attention!

www.renegadematerials.com

Contact: kabbitt@renegadematerials.com