NASA CASE NO. <u>LAR 14863-1-CU</u>

PRINT FIG. <u>1</u>

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Serial No.:   08/141,293
                 10/20/93   LaRC

AWARDS ABSTRACT

NON-RECTANGULAR TOWPREG ARCHITECTURES

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Ribbonized prepreg is used in the automated placement process where ribbons are robotically managed and continually fed onto a tool or part surface and adhered by application of heat and pressure. This automated placement process is particularly sensitive to ribbon material quality when considering low-flow matrix materials. The simultaneous assembly of adjacent ribbons (typically 4 to 34) offers significant advances in the lay-up of composite prepregs. However, the low-flow matrix materials (which are often high performance) combined with lack of ribbon cross-sectional dimensional integrity, and most importantly, the existence of the standard rectangular cross-section, complicates the automated placement process frequently rendering poor results.

By the present invention, prepreg ribbons were made having a cross-sectional geometry which promotes intimate lateral contact between adjacent composite tows. Examples of this cross-sectional geometry include a triangle, a trapezoid, a parallelogram, and a polygon having more than 4 sides. Essentially, any shape will work provided that it is not rectangular or circular and allows for nesting on consolidation.

The novelty of this invention resides in the prepreg ribbon having a cross-sectional geometry which allows for intimate lateral contact or nesting between adjacent tows. The rectangular cross-sectional geometries of the prior art do not allow for nesting.

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NON-RECTANGULAR TOWPREG ARCHITECTURES

Cross-Reference to Related Applications

This application is related to co-pending patent application serial

5   number_____, filed _____, entitled "Apparatus for
Providing a Uniform, Consolidated, Unidirectional, Continuous, Fiber-Reinforced
Polymeric Material and Method Relating Thereto".

Origin of the Invention

10   The invention described herein was made by an employee of the United
States Government and two contract employees in the performance of work
under NASA Grant Numbers NGT 51008 and NAG 1067 and is subject to the
provisions of Public Law 96-517 (35 U.S.C. 202) in which the contractors have
elected not to retain title.

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Background of the Invention

1. Field of the Invention

The present invention relates generally to prepreg ribbons. In particular,
it relates to prepreg ribbon forms which have non-rectangular architectures.

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2. Description of the Related Art

Ribbonized prepreg is used in the automated placement process where
ribbons are robotically managed and continually fed onto a tool or part surface

25   and adhered by application of heat and pressure. This automated placement
process is particularly sensitive to ribbon material quality when considering low-
flow matrix materials. The simultaneous assembly of adjacent ribbons (typically
4 to 34) offers significant advances in the lay-up of composite prepregs. The
low-flow matrix materials (which are often high performance) combined with

30   lack of ribbon cross-sectional dimensional integrity, and most importantly, the

existence of the standard rectangular cross-section, complicates the automated placement process frequently rendering poor results. Although ribbons are bonded to their vertical neighbor (directly below) satisfactorily, the failure to make quality parts is generally attributed to the poor bonding of adjacent

5   ribbons to each other. Low-flow thermoplastic parts made by using slit prepreg tapes are typically unconsolidated and exhibit excessive porosity and void content. High to moderate-flow matrix prepreg tapes and ribbons generally provide well consolidated, void-free parts. This contrast can be attributed to the correcting melt-flow nature of the high-flow matrix which allows for simultaneous

10   congregation and filament intermingling of neighboring ribbons.

An object of the present invention is to provide a prepreg ribbon having a cross-sectional geometry which promotes intimate lateral contact between adjacent composite tows.

Another object of the present invention is to prepare a composite from

15   the prepreg ribbons having the aforementioned geometry.

Summary of the Invention

The objects of the present invention were met by providing a prepreg

20   ribbon having a cross-sectional geometry which promotes intimate lateral contact or nesting between adjacent tows. The cross-section has a plane of contact which provides intimacy of joining upon normal processing. Examples of such cross-section include a triangle, a trapezoid, a parallelogram, and a polygon having more than 4 sides. Essentially, any shape will meet the

25   objectives of the invention as long as it is not rectangular or circular and allows for nesting of the ribbons upon consolidation.

Brief Description of the Drawings

Figure 1 is a diagram of the alternate prepreg ribbon architectures.

Figure 2 is a diagram of the grouping and alignment of the ribbons.

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Description of the Preferred Embodiments

As a measure of the capabilities of the current technology, a low-flow hot-melt prepreg tape was slit into 1/4 inch rectangular ribbons and robotically placed onto a tool surface. Following a robotic in-situ manufacturing process known to those skilled in the art, a flat panel section was produced. The panel was placed into an autoclave and processed under vacuum, pressure and heat. The resulting panel contained adjacent ribbon tops and gaps. Mechanical testing proved this part was unacceptable.

A low-flow, 12K, powder coated towpreg was heated and shaped into a non-rectangular cross-sectional architecture. This was achieved by continuously pulling the powder coated towpreg through a forming means wherein the towpreg was consolidated and pre-shaped into a wide, flat, cross-sectional form. Upon exiting the forming means, the towpreg was consolidated into a malleable, wide, flat, cross-sectional form and passed into a shaping means. The shaping means reshaped the malleable, consolidated, flattened polymeric prepreg material into a towpreg having a non-rectangular cross-sectional architecture. Utilizing the same process as that which was disclosed for the slit tape, a composite part was fabricated. The part was well consolidated.

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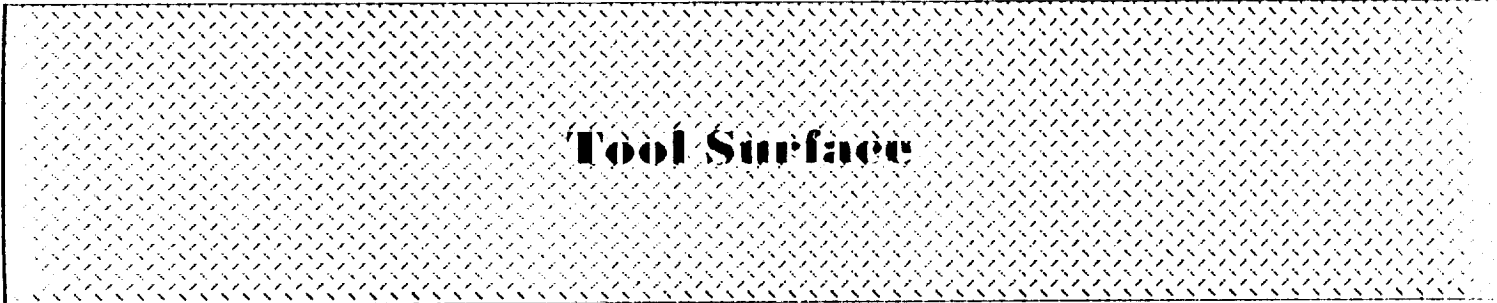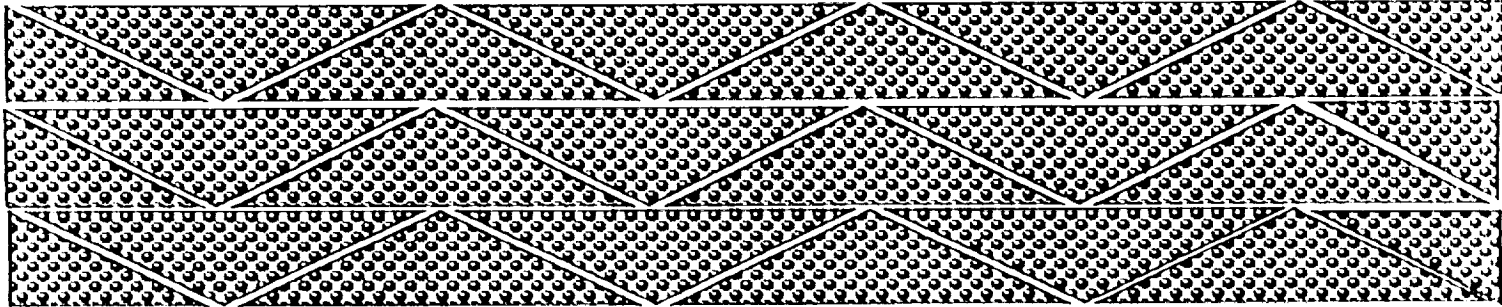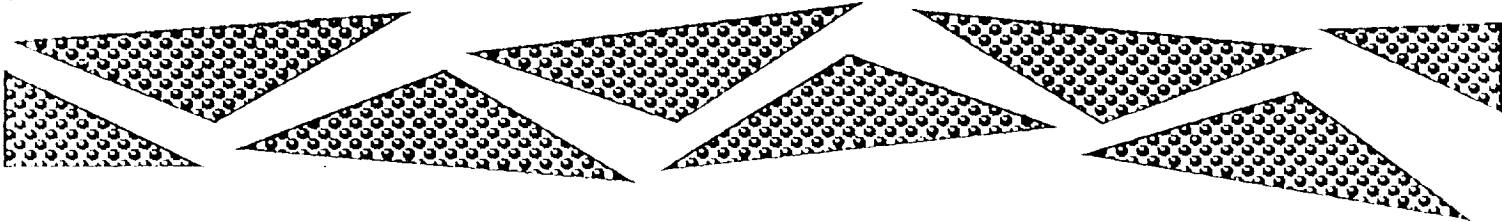## NON-RECTANGULAR TOWPREG ARCHITECTURES

Abstract of the Disclosure

A shaped towpreg ribbon having a cross-sectional geometry which promotes intimate lateral contact between adjacent composite tows was prepared. The cross-sectional geometry is non-rectangular and promotes intimate lateral contact between adjacent towpreg ribbons during normal processing.

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FIG. 1
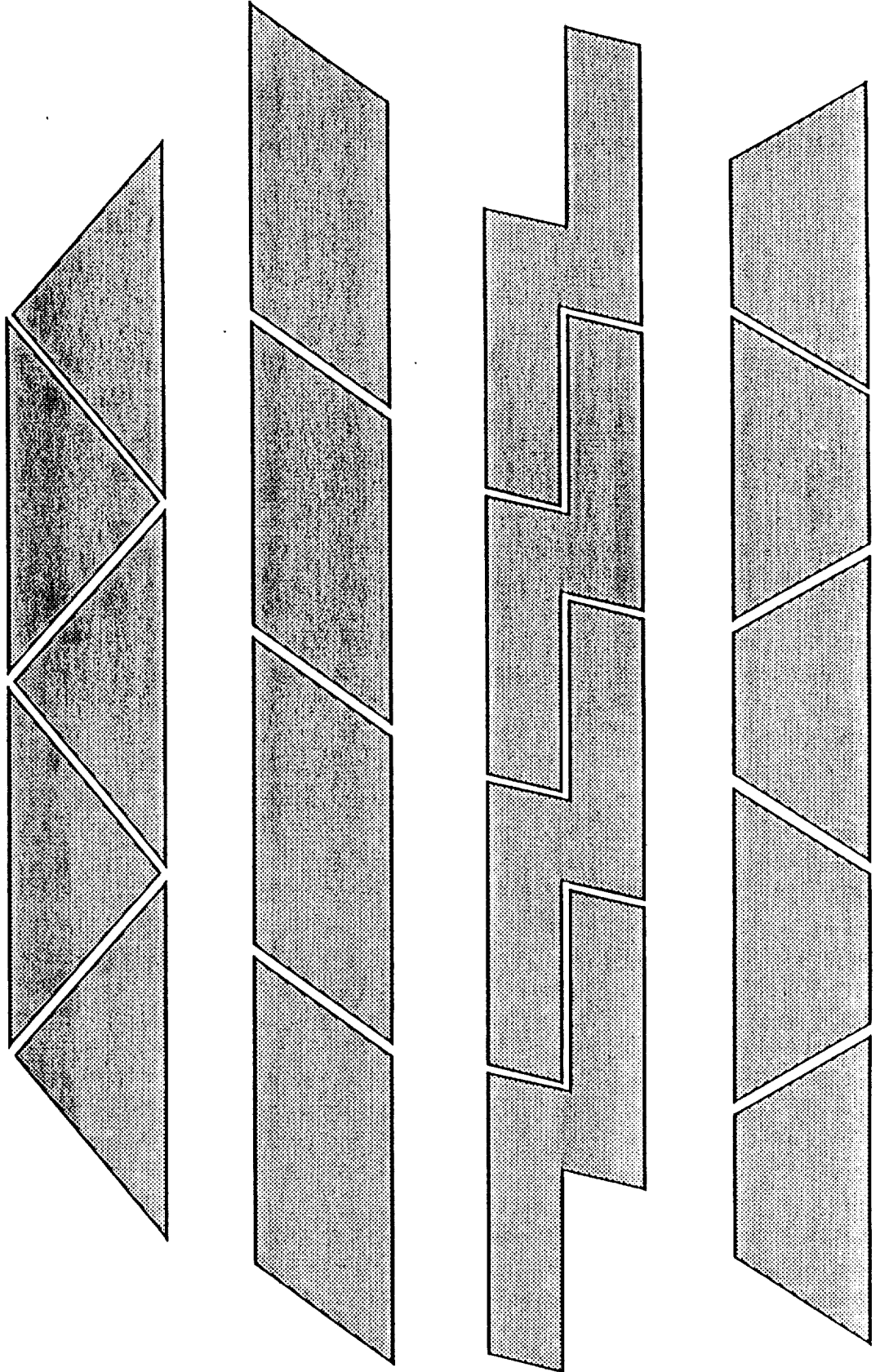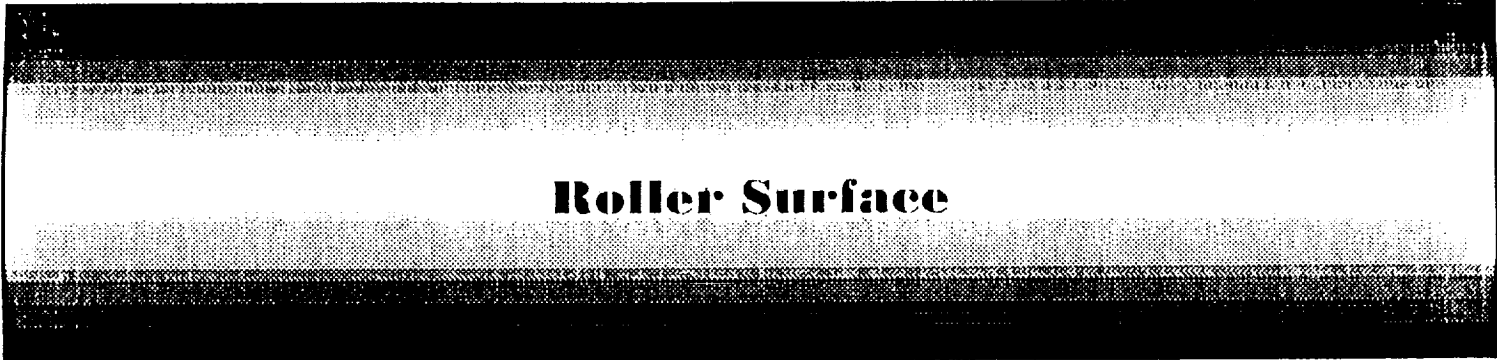
Roller Surface

Tool Surface

FIG. 2