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SPIDER SILK

PORAV Viorica

University of Oradea, Romania, Department of Engineering and Industrial Management in Textiles and Leatherwork, Faculty of Energy Engineering and Industrial Management, Str. B.Şt Delavrancea nr.4, 410087, Oradea, Bihor, Romania, E-mail:textile@uoradea.ro
E-Mail: textile@uoradea.ro

Corresponding author: Porav Viorica, E-mail: viorica.porav@gmail.com

Abstract: *The strengthness and toughness of spider fiber and its multifunctinal nature is only surpassed in some cases by synthetic high performance fibers. In the world of natural fibers, spider silk has been long time reconized as a wonder fiber for its unique combination of high strength and rupture elongation. Scientists in civil military engineering reveal that the power of biological material (spider silk) lies in the geometric configuration of strctural protein, and the small cluster of week hydrogen bonds that works toghethter to rezist force and dissipate energy. Each spider and each type of silk has a set of mechanical properties optimised for their biological function. Most silks, in particular deagline silk, have exceptional mechanical properties. They exhibit a unique combination of high tensile strength and extensibility (ductility). This enables a silk fiber to absorb a lot of energy before breaking (toughness, the area under a stress- strain curve). A frequent mistake made in the mainstream media is to confuse strength and toughness when comparing silk to other materials. As shown below in detail, weight for weight, silk is stronger than steel, but not as strong as Kevlar. Silk is,however, tougher than both.This paper inform about overwiew on the today trend in the world of spider silk.*

Key words: *Spider silk, combined strength and toughness, artificial muscle, metalized spider fiber*

1. INTRODUCTION

Spider silk is un natural material wich has been in the attention of the scientist for along time because its proprieties.Spider silk is a protein fiber spun by spiders. Spiders use their silk to make webs or other structures, wich function as nets to catch other animals, or as nests or cocoons for protection foe their offspring. All spiders produce silks, and a single spider can produce up to seven different types of silk for different uses. Spider silk may be used for a number of different ecological uses, each with properties to meci the function of the silk. [1]

2. GENERAL INFORMATION

Spider silk is five times as strong as steel. Scientists have discovered why spider webs are able to withstand huge forceswithout breaking. Ti fiind aut how much force spider webs can stand, scientists tested real spider webs and ran computer simulations. They found that some spider webs can withstand hurricane-force winds. Spider webs have are incredible. Spider web material is about onetenth the diameter of a human hair, but it has incredible strength. In fact, it is ten times stronger than a steel strand of the same weight.[1]

Spide webs have a very complex design. The way the web is built means that if a singlestrand of web breaks, the strength of the web actually increases.

Spider silk can react differently to different types of forces. If a light wind blow on the web, the silk softnes and become more flexible. The spider web can blow in the breeze without breaking. If a larger force is applied to one part of web, the silk in that part of the web becomes stiff and one or two threads break. The rest of the web stays intact.[1]

The spiders needs strong silk because it take a lot of energy to built a web. If only a couple ofthreads break, the spider dosen`t have to start building a whole web from scratch. Also, spiders need

their webs to catch food. Instead, the web is flexible enough to stretch when an insect lands in it, strong enough not to break andstiky enough to trap the insect.[1]

In spite of the progress made in the last years by polimeric fibers and technologies, the seargh for a toughest and strongest fiber continues. The remarkable proprieties of spider fiber and the progress in biotechnology incresed the interest in using this as the future high quality fiber. However there are production problems. Spiders are difficult to be domesticated and forced to produce silk.

So all over world scientists are trying to make other creature to produce „spider silk". The stucture makes this lightweight natural material as strog as steel or even the Kevlar. Spider sik is a protein. Spiders make webs or other structures functining as catching nets or nest for protection for offsprings.[1, 2] A spider produced several types of fiber for different porposes but in a bigger colonies appears canibalic problems. There are studies about spider silk properties and production by Kaplan, Gosline, Viney, Volrath, Lazaris and Jin. This paper is a overwiew on the today trend in the world of spider silk.[3]

3. MECANICAL PROPERTIES

Some comparative properties (diameter off spider drag line silk in comrparing to other textile fibers) are shown in Table.1 [4]

Table 1: *Diameter of Spider Silk and Other Reference Fibers [4]*

	Liner Density(tex)	**Diameter Mean value (micron)**	**Coeff.Variation %**
Spider Silk	0.014	3.57	14.8
B.mori Silk	0.117	12.9	24.8
Merino Wool	0.674	25.5	25.6
Polyester	0.192	13.3	2.4
Nailon 6	0.235	16.2	3.1
Kevlar 29	0.215	13.8	6.1
Kevlar 49	0.315	13.4	6.2

For example drag line is betwee 3-4 micons in diameter and the cribellate silk was found as fine as 0.03 microns.

Spider silk is unusually strong, resilientand elastic fiber protein that is only surpassed by syntetic fibers. Table 2 [3] compares some selected properties of silk fibers. They have an unbeatible capacity for absorbing energy also known as resilience. This property makes silk fibers attractive for aplication with big energy absorbtion.

Table 2*: Average Values of Mechanical Properties* [3]

FIBER TYPE	**DENSITY (g/cm³)**	**MODULUS OF ELASTICITY (GPa)**	**TENSILE STRENGHT (GPa)**	**BREACKING STRAIN (%)**	**RESILIENCE (M3/m³)**
Spider Silk Argiope trifasciata	1,3	1-10	1,2	30	100
Spider Silk Nephila clavipes	1,3	1-10	1,8	30	130
Silkworm silk	1,3	5	0,6	12	50
Nylon 6,6	1,1	5	0,9	18	80
Kevlar 49	1,4	130	3,6	3	50
PBO	1,6	270	5,8	3	70
Steel	7,8	200	3,0	2	6

Mecanical properties of silk fibers are dependent not only on protein composition but also on spinning process, wich proceed in an aqueous environment. [5] The search for a biological role of supercontraction, possibly in combination with stretching le dto the consideration that the proccesing of the fiber is a situation in wich the fiber would be naturally subjected to both effects.

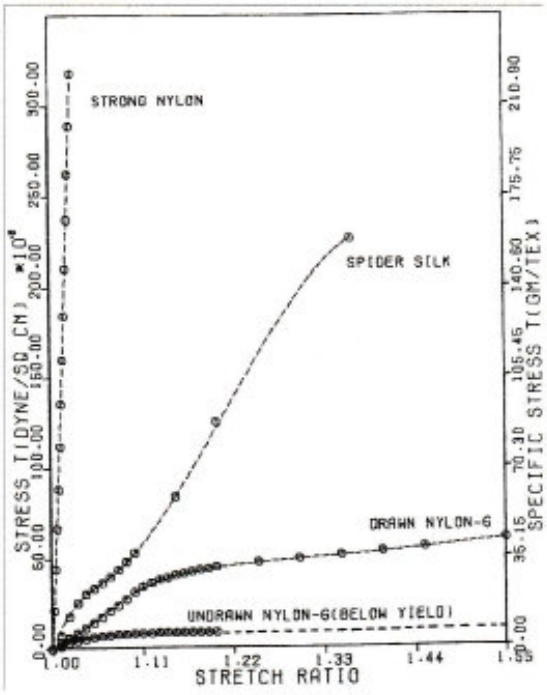

Fig. 1: *Tensile Stress-Strain Curve of Spider Silk and other Polyamide Fibers [4]*

The stress-strain curve of spider silk assumes a sigmoidal shape similar tot hat of an elastomer, demonstrating a well balance of strenght and elongation. [1], [6] The material properties of spider silk are different from specimen to specimen, according tothe ambient and wet conditions

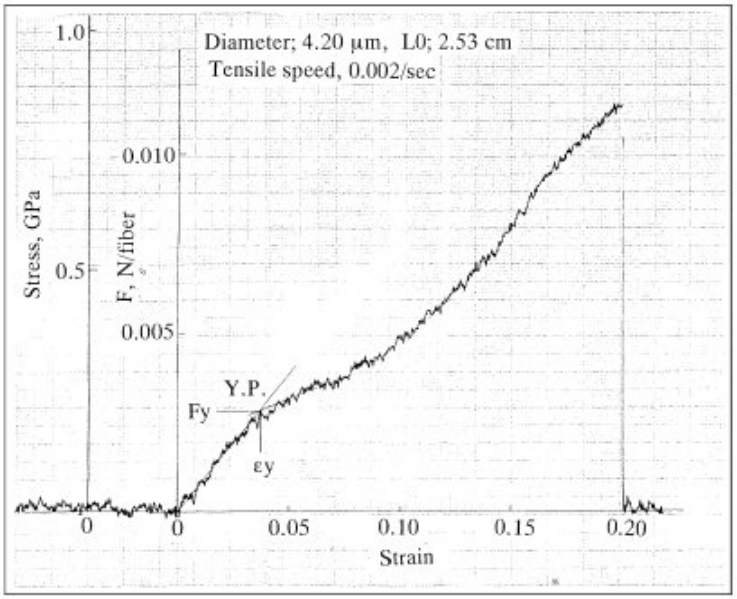

Fig. 2*: Tensile property of Single Fiber [1]*

The spinning process can be carried aut in air or under water producing silk having a wide range of properties and extreme fineness, from 0,01-4 μm. Spider silk is very durable and can resist degradation of environment. [1], [7]

4. CONCLUSIONS

The spider silk is used for a very longtime. It is very interesting that in the years 1920 there was a company in Timisoara that made women stocking of spider silk. Today the mass production is ready for a new begining. There are more possibilities: developing elemental technologies for making microorganisms produce fiber of spider silk, modifying silk worms for spider fiber or even genetically manipuleted goats for spider silk. Soon solving the problem of production costs spider silk will be used in large categories: military, clothes, Kevlar substitute or even artificial muscles. [1,2]

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