

ES.010: Chemistry of clothing

Wednesday April 17th, 2013

Topic list:

1. Weekly workout
2. Chemistry of clothing
3. 3-d printed spikes

Weekly workout

- Thursday April 18th at 4 pm in the Z center MAC Court 3rd floor for a spin workout
- Working on the brick for our mini-tri (which is happening during May 1st class, FYI)

Clothing

- Nylon
- Lycra
- Wetsuits
- Wicking technology

Nylon

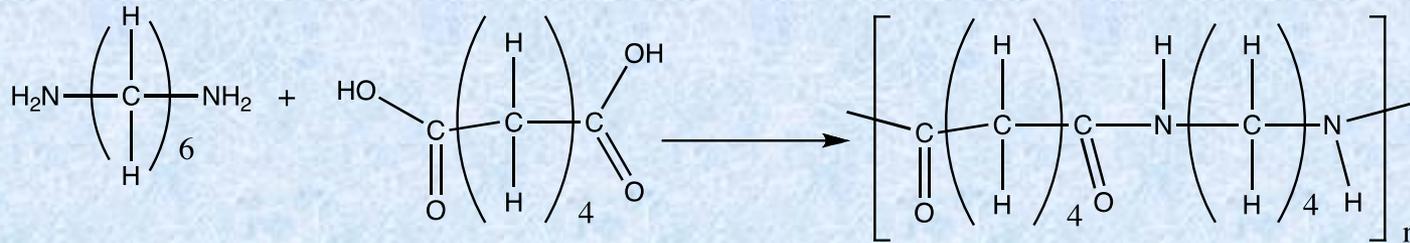
- First prepared in on February 28, 1935 during the depression
- Technically called Nylon 6,6
- Dupont decided to tackle the challenge of substituting nylon for silk in woman's full fashioned hosiery without having to raise the price.

Nylon

- Nylon was an instant market and financial success when it became available in May of 1940. Production of \$9 million sold out with a 33% profit. In the year before World War II, 1941, profits were \$7 million on sales of \$25 million. Du Pont made the nylon for over 60 million pairs of sheer women's hosiery, more than the number of women in the United States at that time

Nylon

- Made from hexamethylene diamine and adipic acid which are derived from the oil industry



Announcement of the 75th birthday party for Nylon

Support Hose

- Support Hose increases blood flow up the legs and relieves swelling in the feet
- The stockings work by forcing the blood in the lower leg, where the hose is tightest, up toward the heart
- Used to prevent leg vein thrombosis
- Ref: *New York Times* article on Support Hose
- Reference:
http://www.makemeheal.com/mmh/product/compression_stocking/index.vm?procid=28

Exercise use of Support hose

- From the *Running Times*
- Compression Socks -- snug-fitting, over-the-calf socks (some of which start at the ankle) aimed at improving oxygen delivery to muscles, speeding lactic acid removal and stabilizing the lower leg for greater muscle efficiency.

Exercise use of Support Hose

- Where you can get your own socks

More use of Compression clothing

- Get running/biking compression shorts, compression underwear, calf sleeves,
- **Recovery sleeves**
- Compression clothing is everywhere! Even for the everyday athlete

Why spend the money on compression socks?

Ménétrier et al, 2011.

Compression Sleeves Increase Tissue Oxygen Saturation But Not Running Performance

The purpose of this study was to determine the effects of calf compression sleeves on running performance and on calf tissue oxygen saturation (StO_2) at rest before exercise and during recovery period. 14 moderately trained athletes completed 2 identical sessions of treadmill running with and without calf compression sleeves in randomized order. Each session comprised: 15 min at rest, 30 min at 60% maximal aerobic velocity determined beforehand, 15 min of passive recovery, a running time to exhaustion at 100% maximal aerobic velocity, and 30 min of passive recovery. Calf StO_2 was determined by near infra-red spectroscopy and running performance by the time to exhaustion.

Why spend the money on compression socks?

Ménétrier et al, 2011.

Compression Sleeves Increase Tissue Oxygen Saturation But Not Running Performance

Compression sleeves increased significantly StO_2 at rest before exercise ($+ 6.4 \pm 1.9\%$) and during recovery from exercise ($+ 7.4 \pm 1.7\%$ and $+ 10.7 \pm 1.8\%$ at 20th and 30th min of the last recovery period, respectively). No difference was observed between the times to exhaustion performed with and without compression sleeves (269.4 ± 18.4 s and 263.3 ± 19.8 s, respectively).

Within the framework of this study, the compression sleeves do not improve running performance in time. However the StO_2 results argue for further interest of this garment during effort recovery.

More research on compression socks

Ali et al (2011): The effect of graduated compression stockings on running performance.

The aim of this study was to examine the effects of wearing different grades of graduated compression stockings (GCS) on 10-km running performance. After an initial familiarization run, 9 male and 3 female competitive runners ($VO_2\text{max}$ $68.7 \pm 5.8 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$) completed 4 10-km time trials on an outdoor 400-m track wearing either control (0 mm Hg; Con), low (12-15 mm Hg; Low), medium (18-21 mm Hg; Med), or high (23-32 mm Hg; Hi) GCS in a randomized counter balanced order. Leg power was assessed pre and postrun via countermovement jump using a jump mat. Blood-lactate concentration was assessed pre and postrun, whereas heart rate was monitored continuously during exercise.

More research on compression socks

Ali et al (2011): The effect of graduated compression stockings on running performance.

Perceptual scales were used to assess the comfort, tightness, and any pain associated with wearing GCS. There were no significant differences in performance time between trials ($p = 0.99$). The change in pre to postexercise jump performance was lower in Low and Med than in Con ($p < 0.05$). Mean heart rate ($p = 0.99$) and blood lactate ($p = 1.00$) were not different between trials. Participants rated Con and Low as more comfortable than Med and Hi ($p < 0.01$), Med and Hi were rated as tighter than Low ($p < 0.01$), all GCS were rated as tighter than Con ($p < 0.01$), and Hi was associated with the most pain ($p < 0.01$). In conclusion, GCS worn by competitive runners during 10-km time trials did not affect performance time; however Low and Med GCS resulted in greater maintenance of leg power after endurance exercise. Athletes rated low-grade GCS as most comfortable garments to wear during exercise.

Worth the money?

Sperlich et al, 2010. Different types of compression clothing do not increase sub-maximal and maximal endurance performance in well-trained athletes.

Three textiles with increasing compressive surface were compared with non-compressive conventional clothing on physiological and perceptual variables during sub-maximal and maximal running. Fifteen well-trained endurance athletes (mean \pm s: age 27.1 \pm 4.8 years, $VO_{(2max)}$ 63.7 \pm 4.9 ml x min⁻¹ x kg⁻¹) performed four sub-maximal (approximately 70% $VO_{(2max)}$) and maximal tests with and without different compression stockings, tights, and whole-body compression suits. Arterial lactate concentration, oxygen saturation and partial pressure, pH, oxygen uptake, and ratings of muscle soreness were recorded before, during, and after all tests. In addition, we assessed time to exhaustion.

Worth the money?

Sperlich et al, 2010. Different types of compression clothing do not increase sub-maximal and maximal endurance performance in well-trained athletes.

Sub-maximal ($P=0.22$) and maximal oxygen uptake ($P=0.26$), arterial lactate concentration ($P=0.16$; 0.20), pH ($P=0.23$; 0.46), oxygen saturation ($P=0.13$; 0.26), and oxygen partial pressure ($P=0.09$; 0.20) did not differ between the types of clothing (effect sizes= 0.00 - 0.45). Ratings of perceived exertion ($P=0.10$; 0.15), muscle soreness ($P=0.09$; 0.10) and time to exhaustion ($P=0.16$) were also unaffected by the different clothing (effect sizes= 0.28 - 0.85). This was the first study to evaluate the effect on endurance performance of different types of compression clothing with increasing amounts of compressive surface.

Overall, there were no performance benefits when using the compression garments.

The real value of compression clothing

- Is during recovery after exercise not during exercise
- It is an aid to allow your muscles to recover from one workout, so you can go to the next workout.

Clothing

- Nylon
- Lycra
- Wetsuits
- Wicking technology

Lycra

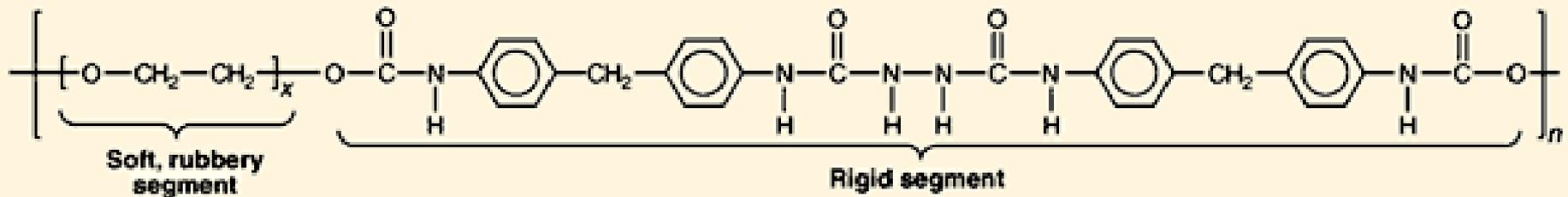
- LYCRA[®] fiber is a man-made elastane fiber. Never used alone, but always blended with other fibers, it has unique stretch and recovery properties. LYCRA[®] fiber adds comfort, fit, shape retention, durability and freedom of movement. This is achieved thanks to the unique properties of the fiber, which can be stretched up to seven times its initial length before springing back to the original position once tension is released.

What is Spandex?

- Spandex is a man-made elastic fiber. It is derived from crude oil and is described in chemical terms as segmented polyurethane. It stretches under tension and recovers its original length when tension is relaxed. It can be stretched four to seven times its original length. It is combined with other 'hard' yarns to produce elastane stretch fabrics.
- Essentially, Lycra[®] and Spandex are the same thing. Lycra[®] is a brand name. Spandex is the generic name used in the US and Canada for elastane. Elastane is the name used in the rest of the world.

Lycra

- LYCRA[®] fiber was invented in 1958 by a team of scientists, originally as a replacement for rubber in corsetry. Before LYCRA[®] fiber was invented, consumers endured saggy, baggy, stretched and bunched clothes. But when the DuPont scientist Joe Shiver perfected a revolutionary new fiber – code named K, that all changed.



Lycra

- In the 1960s, LYCRA® fiber revolutionized the way in which fabrics could be used. In beachwear it replaced thick and heavy swimsuits with light, quick-drying garments like the bikini.
- In 1968, the medal-winning French Olympic ski team became the first high-profile sports personalities to wear ski suits with LYCRA® fiber – a trend that soon spread to other sports.
- By 1972 Olympic swimmers swore by the sleek, lightweight suits with LYCRA® fiber.

Lycra

- 1990s - During the 1990s, the LYCRA® fiber brand position in the sports market strengthened through the development of hi-tech fibers such as LYCRA® Power™ fabric in compression shorts which help reduce athletes' muscle fatigue. This decade also saw the rising popularity of the fiber not just in women's fashion but in men's too.

Lycra

- A lot of clothing contains Lycra
- Examples include: bathing suits, leggings, any cotton blend with a form fitting appearance, gymnastics costumes. Cycling shorts, cycling tops

Clothing

- Nylon
- Lycra
- **Wetsuits**
- Wicking technology

Wetsuits

- Information about triathlon [wetsuits](#)
- Don't want a wetsuit? How about a swim [skin?](#)

Fastskin[®] LZR Racer[®] by Speedo

- The Fastskin[®] LZR Racer[®] is the result of some of the most extensive research in swimwear history.
- Made from an ultra lightweight, low drag, water repellent, fast drying fabric, unique to Speedo, called LZR Pulse[®], the LZR Racer[®] is the world's first fully bonded swimsuit.
- look behind the [technology](#)

Illegal swim suits

- **New rules** for swim suits now

Carbon fibers/nanotubes

- Carbon nanotubes are single or multiple atomic layers of graphite wound into tubes. Because of their size and composition, they have unique electrical, mechanical and other physical properties. Their light weight, strength and resistance to corrosion make them ideal for use in a variety of applications, including flexible optoelectronic devices for energy harvesting and energy storage, compressed natural-gas tanks, and aerospace and sports equipment.

Where are carbon fibers found now?

Tennis

- In tennis, carbon nanotechnology is used to increase the strength of tennis racquets by adding **carbon nanotubes** to the frames which increases control and power when you hit the ball. Furthermore, they also reduce the rate of air leaks from tennis balls, so they keep their bounce longer.
- **Nanocyl carbon nanotubes** are not only added to tennis racquets to stiffen the racquet and to increase the power. They are also used for other sporting goods as golf balls and golf clubs.

Golf

- In golf, **carbon nanotubes** from **Nanocyl** are used for filling any imperfections in the club shaft materials with nanoparticles. This improves the uniformity of the material that makes up the shaft and thereby improving the swing.
- When making a golf shaft, it is not always perfectly straight. There are often gaps in the shaft – adding **carbon nanotubes** in the tiny spaces in the golf shaft, gives the latter a tighter molecule structure. When applied in its raw state, the shaft is more uniform, more consistent and more dense, which makes the golf shaft stronger, and by consequence straighter.

Where are carbon fibers found now?

Nanocyl provides high-quality **Carbon Nanotube** (CNT) technologies.

From their website:

- The use of composite materials in the sporting goods industry has grown exponentially, and so has the demand for Nanocyl's EPOCYL™ products.
- These products offer sporting goods designers and manufacturers an integrated, innovative technology for improving the strength, fracture toughness, shelf life, and antistatic properties in composite parts. Common applications include bike frames, hockey sticks, tennis rackets, golf shafts, and skis.
- Nanocyl's **Carbon Nanotubes** Technology gives sporting goods companies and brand enthusiasts the competitive edge they can see and feel—**damping behavior** and **impact resistance** which powers the design, manufacture, and use of **lighter and resilient products**.

Carbon nanotubes are even in swim suits!

http://www.swimoutlet.com/blogdetail.asp?l_id=203&Click=3049557&utm_source=newsletters&utm_medium=email&utm_campaign=cp13026

http://www.swimoutlet.com/product_p/7531026.htm

Cool shoes for elite athletes

- Using 3-D printing technology to be able to customize the spikes of running shoes for elite track athletes (from New Balance)

http://www.bostonmagazine.com/health/blog/2013/03/18/check-out-new-balances-new-3d-sneaker/?utm_source=iContact&utm_medium=email&utm_campaign=Boston%20Daily&utm_content=

Wicking technology

- Moisture wicking clothing allows users to stay dry to reduce skin irritation and guard against steam burns and other heat related injuries.
- How does this affect your athletic performance?

Even Crocs is in the game!

- Prepair™ Slide
- From their website: crocs.com
- Take off your cleats and slip into a classic slide sandal with Prepair™ benefits.
- Enhances recovery after athletic activity
- Reduces peak pressure during walking by 50% compared to barefoot.*
- Reduces peak muscular effort during walking by 21% compared to barefoot.*

Even Crocs is in the game!

- Crocs™ Rx Orthocloud™ Travel socks are all designed to help people with sensitive feet lead a more active lifestyle. People with diabetes, circulatory problems and foot complaints may benefit from reduced friction against the skin. A patented technology uses moisture-wicking coolmax fibers to keep feet cool and dry.
- <http://www.crocs.com/rx-collection/rx-collection,default,sc.html>

Comments by the class?

- Any cool new products that use technology?
- What new equipment are you using?

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ES.010 Chemistry of Sports

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