FRESH KICKS

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Problem

White shoe sidewalls

1. Easily dirtied by:
   a. Mud/dirt
   b. Plant fluids/other stains
   c. Other pigments/substances
2. Dirtying is exacerbated by:
   a. Scuffing/abrasion
   b. Cutting by various objects
   c. Piercing by various objects
3. Dirtied shoes are replaced more quickly
   a. Expensive for owners
   b. More waste in environment

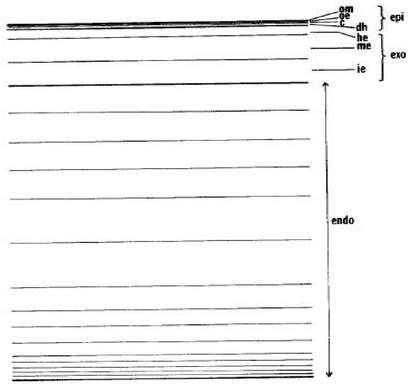
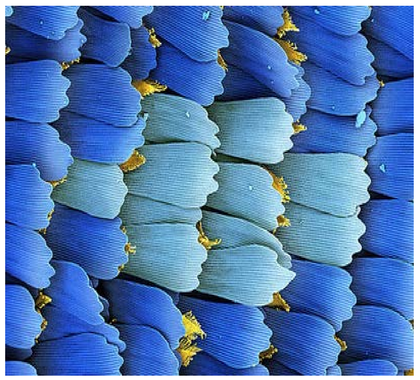
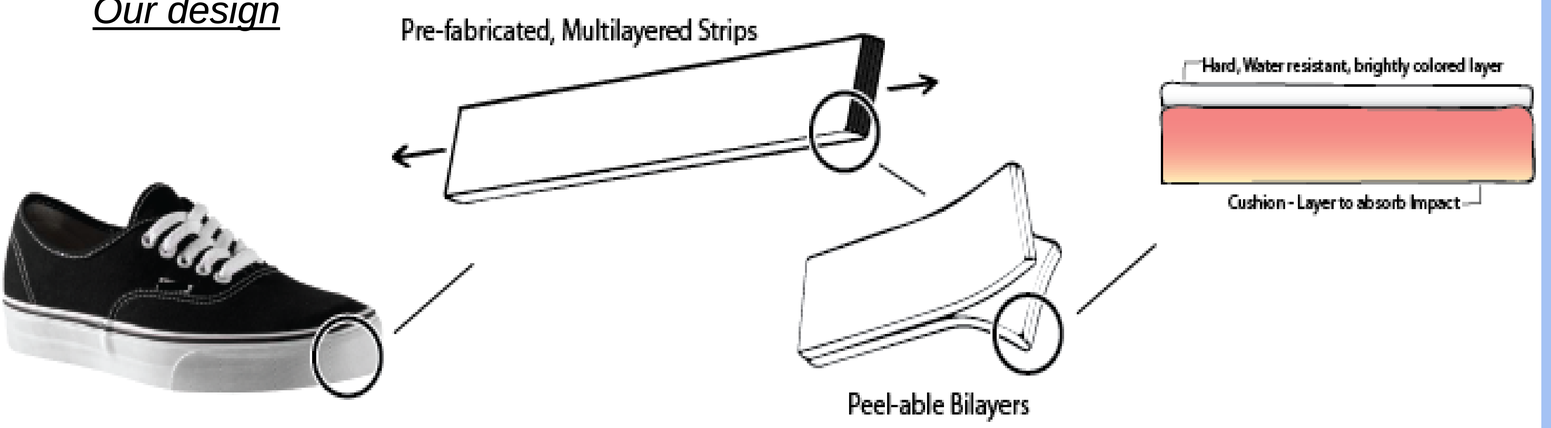


Diagram of scorpion cuticle structure



Microscope image of butterfly scales

Our design



Design Analogies

Perpetually White Shoe Sidewall		Desert Scorpion Cuticle		Morpho Aega Butterfly Scales
Operational Environment		**Operational Environment**		**Operational Environment**
Soft soils/grasses	DIFFERENT	Sand/hard soil	DIFFERENT	Airborne particles
Hard soils and gravels	SIMILAR	Sand/hard soil	DIFFERENT	Spider Webs
Water and mud	DIFFERENT	Dry substrates	SIMILAR	Moisture in air
Man-made surfaces	DIFFERENT	Natural environment	DIFFERENT	air (not ground)
Hot and cold weather	SAME	Hot days and cold nights	SAME	warm and cool climates
Functions		**Functions**		**Functions**
Maintain whiteness	DIFFERENT	Protect scorpion	DIFFERENT	Protects from external adhesive materials
Reduce/prevent cuts and abrasion	SAME	Reduce abrasion from sand-blown wind	DIFFERENT	Sheds scales
Eliminate dirt, mud, other contaminants	SIMILAR	Modify airflow to reduce exposure to sand	SAME	shed scales that have adhesive particles
Specifications		**Specifications**		**Specifications**
Does not interfere with shoe style	DIFFERENT	Camoflauges scorpion in desert	DIFFERENT	Does not deter flight
Is feasible and affordable to manufacture	DIFFERENT	Is able to grow	DIFFERENT	simple mechanical shedding
Does not require significant work to maintain	SIMILAR	Must function without maintenance	SIMILAR	shedding occurs passively
Able to withstand impacts typical for shoes	SIMILAR	Able to withstand impacts from environment	SIMILAR	Able to withstand impacts from environment
removes mud on shoes	SIMILAR	reduces exposure to dirt and sand	SAME	removes dirt, web-silk, etc
Criteria		**Criteria**		**Criteria**
Keeps shoe sidewall in visually like-new condition	DIFFERENT	Keeps scorpion safe in desert environment	DIFFERENT	Frees butterfly from obstructions
More abrasion resistant than regular sidewall	DIFFERENT	As resistant to abrasion as necessary for survival	DIFFERENT	leaves scars where scales shed

Our Design

- Layered, "tear-off" system for instant, easy cleaning, based on butterfly scales
- Each layer contains dual-strength bilayer, based on abrasion and impact resistant cuticle of scorpion
- Manufactured in pre-layered sheets or strips
- Easily adaptable to current shoe designs
- Anisotropic Bilayer makes sidewalls resilient to scratching, abrasion and puncturing, while removing easily to counter adhesion and staining

Design Superiority

- Very thin
- Easy application to existing shoe styles
- Keeps shoes looking new
- Lasts for over 2 years with a single application
- Resists abrasion, removes dirt and stains

Alternate Sources of Biological Inspiration

Desert Scorpion

- Alternating hard & soft layered cuticle
- Resists beating from sand and winds
- Abrasion/impact resistant

Butterfly Scales

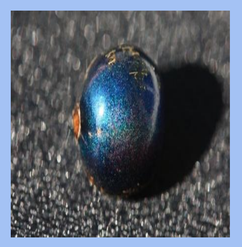
- Layered scales with anisotropic weakness
- Normal force causes scales to shed
- Adhesion resistant

Butterfly Wings

- Hydrophobic nanostructure
- Water beads and carries away dirt
- Passively self-cleans

Pitcher Plant

- Anisotropic microstructure
- Both hydrophobic & oleophobic
- Non-stick surface



Marble Berry

- Tightly coiled cellulose
- Constructive interference, Bragg Reflection
- Maintains bright color