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Homogenized Yarn-Level Cloth

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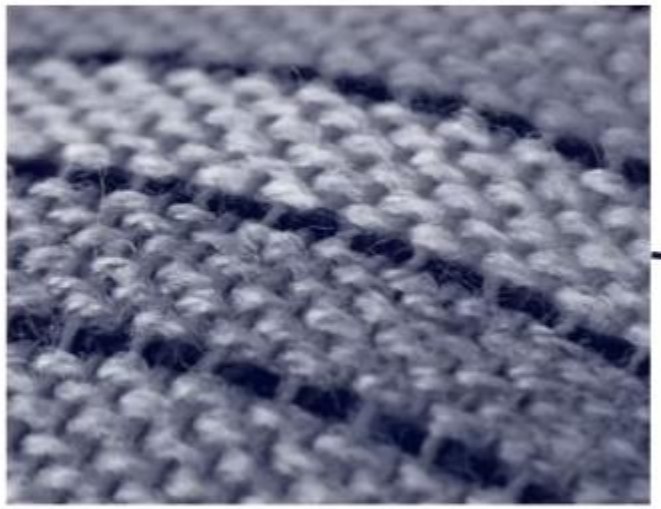
Fig. 1. Left: A comparison between direct yarn-level simulation (YLC) and simulation with our homogenized model (HYLC); our homogenized model accurately captures the non-trivial elastic stretching and bending response of the fabric. Middle and right: Results simulated with homogenized continuum models of woven and knitted patterns; our method allows us to efficiently compute large-scale simulations where direct yarn-level simulation would be prohibitively slow.

Présenté par: Abdelmouttaleb Dakri

Propriétés des tissus

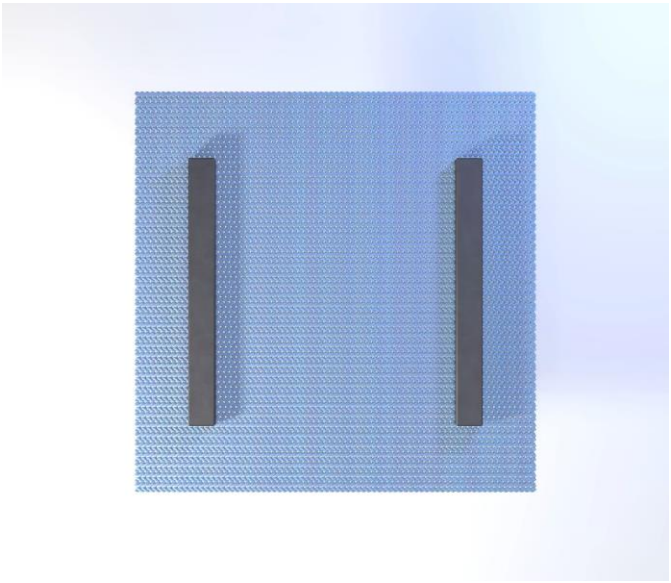
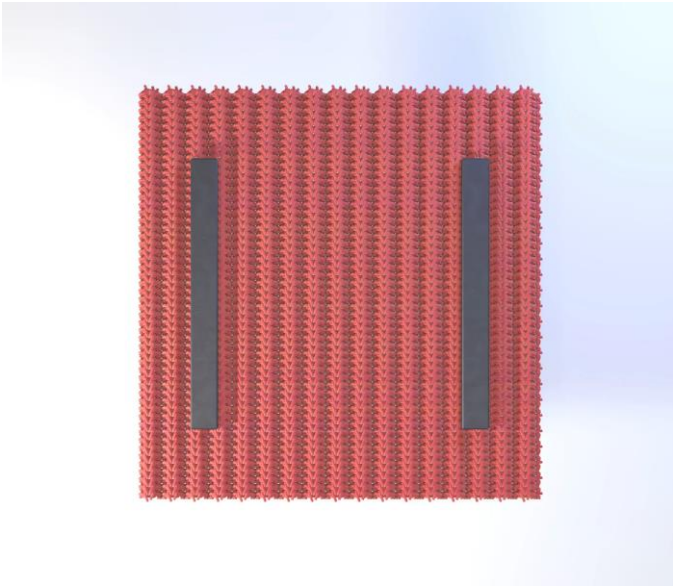
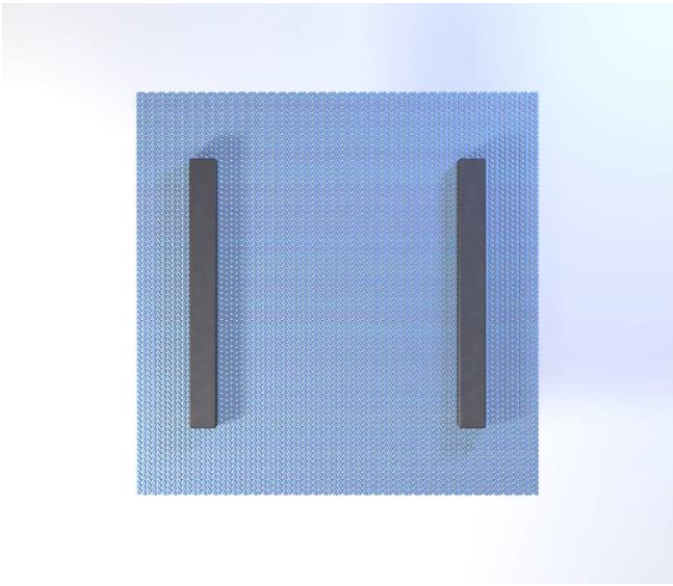
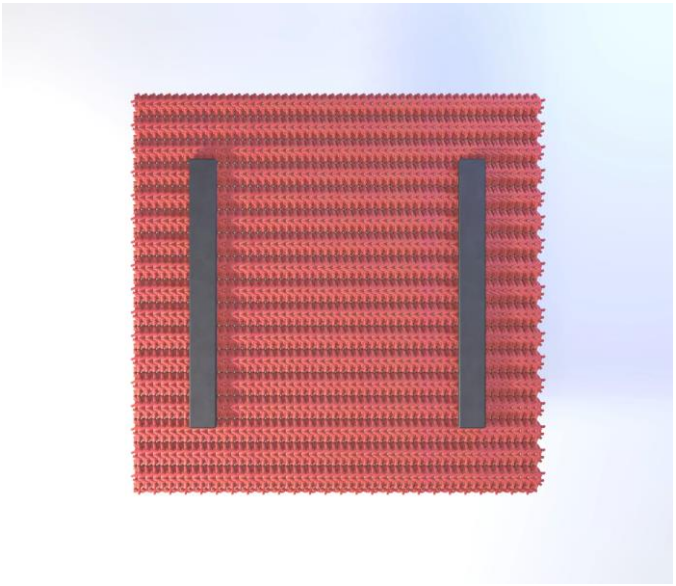
Tissé



Tricoté

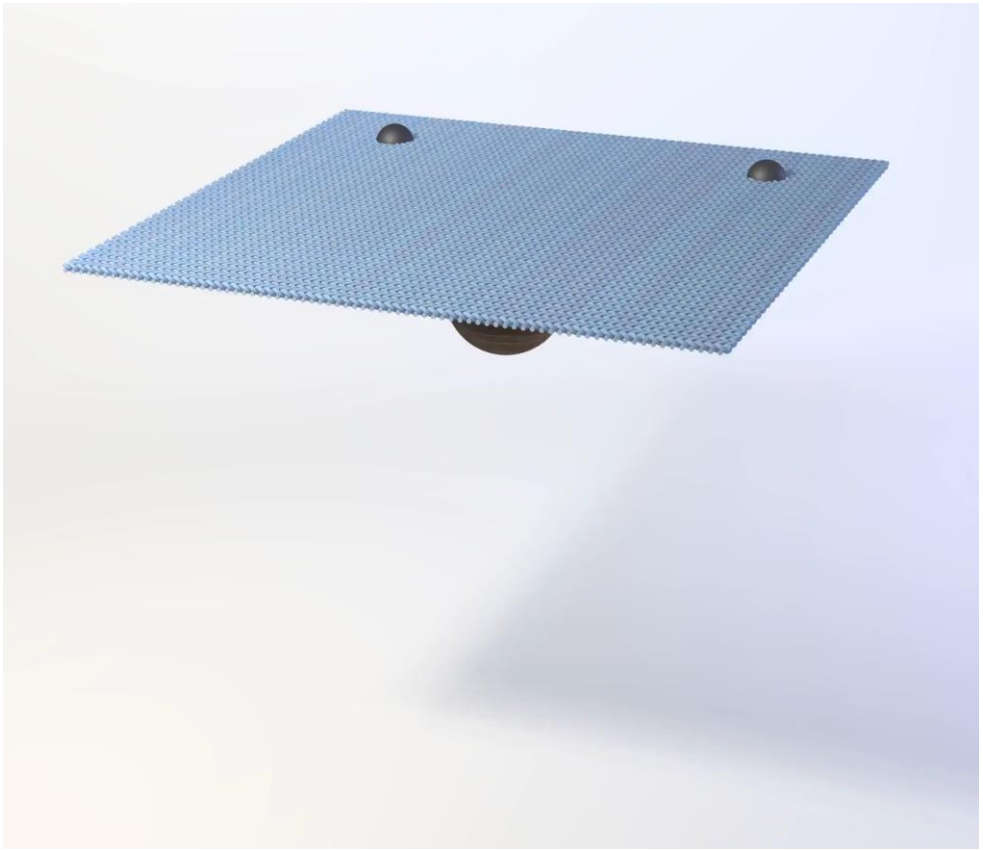
→ Différents comportements élastiques selon le motif (“pattern”)

Propriétés des tissus en traction

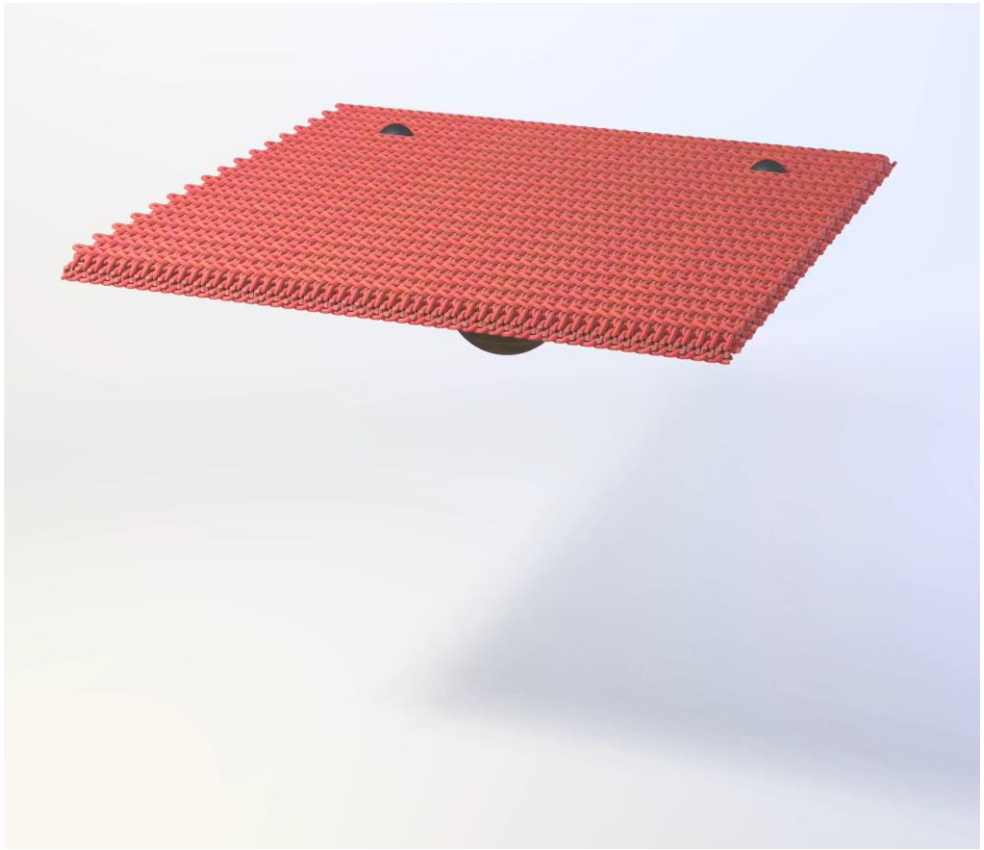
	Motif (stockinette)	Motif (rib/points côtelés)
Traction en X		
Traction en Y		

Propriétés des tissus en flexion

Motif (stock)

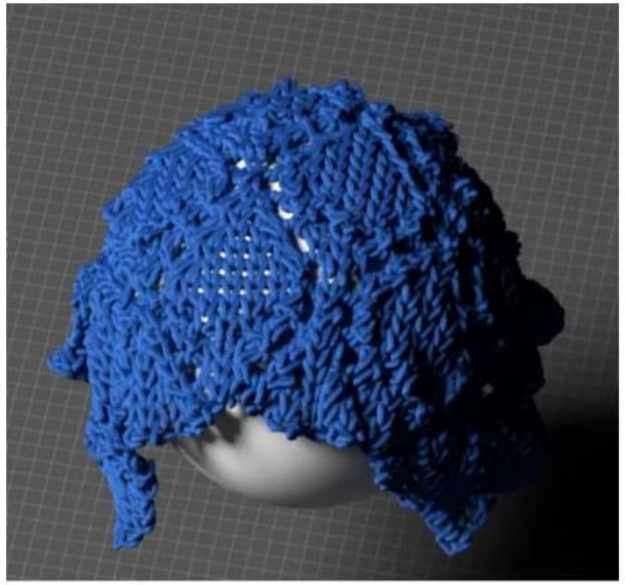


Motif (rib)

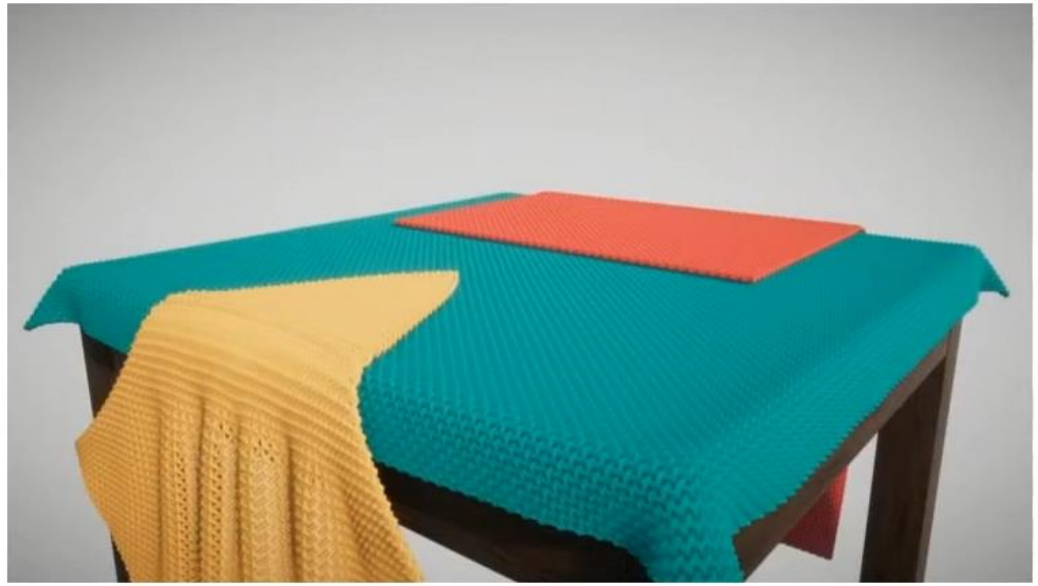


Etat de l'art: Simulation au niveau du fil

[Kaldor et al. 2008]



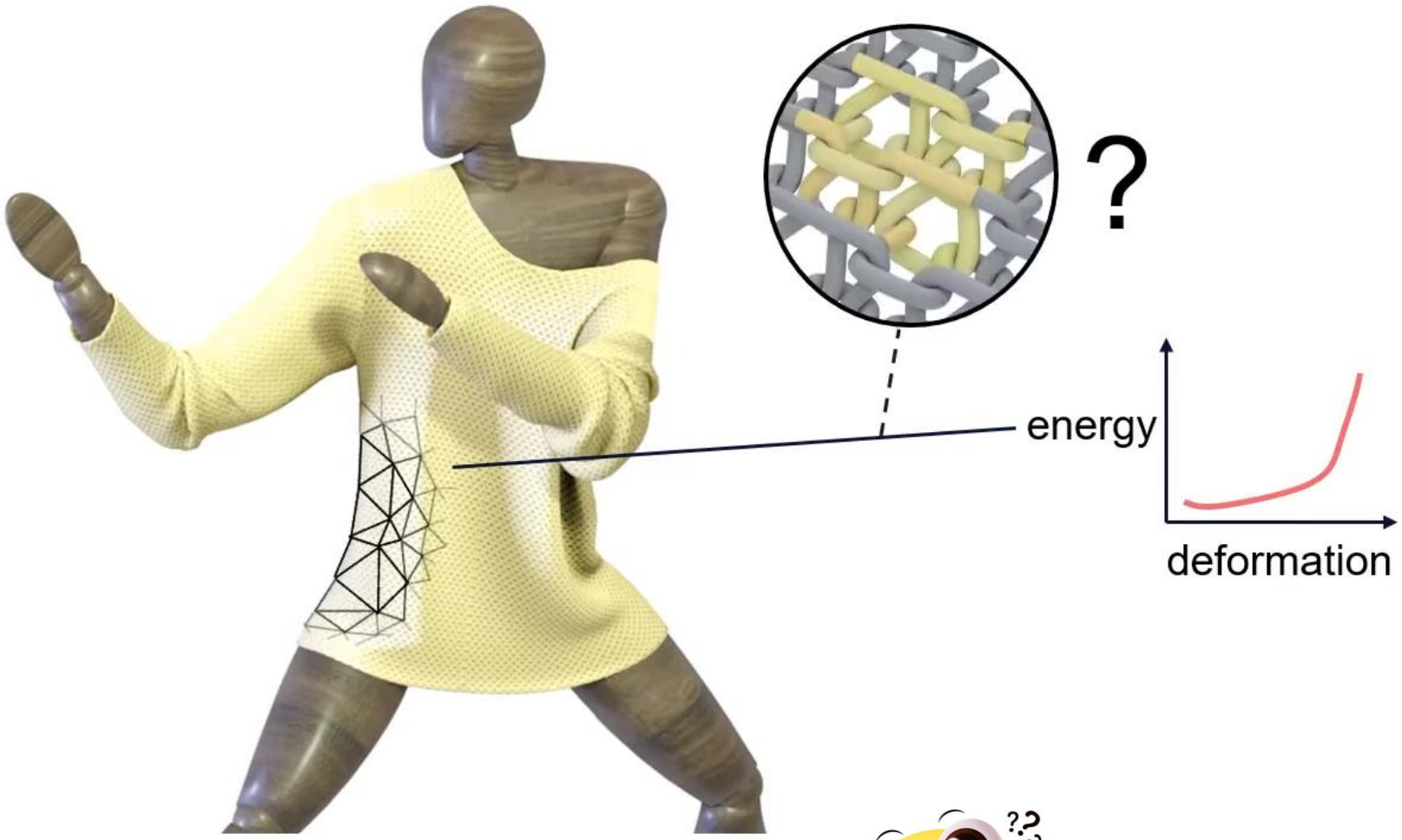
[Cirio et al. 2016]



[Sánchez-Banderas et al. 2020]

→ Simulation très coûteuse! (surtout à l'échelle de vêtements)

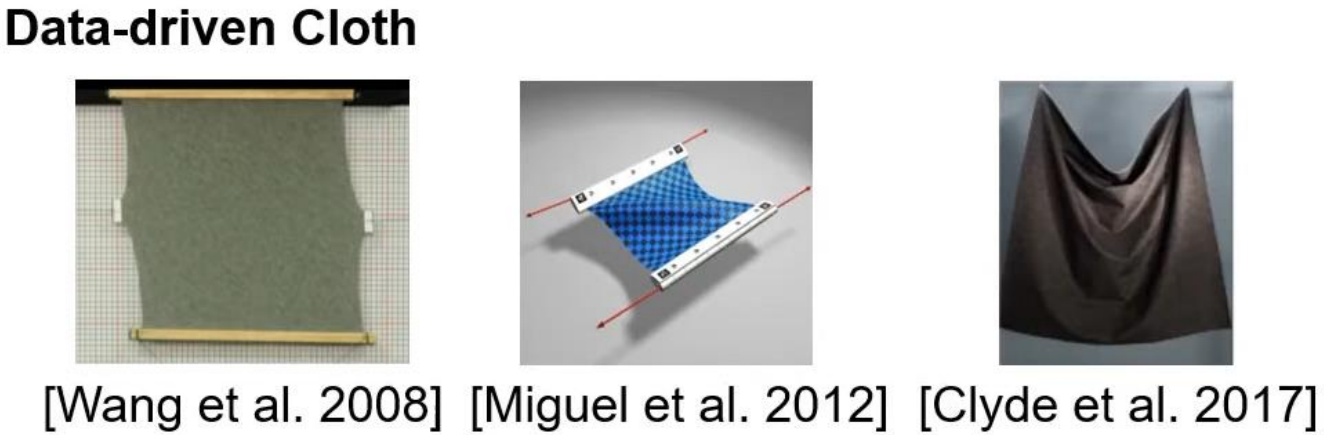
Etat de l’art: Éléments Finis



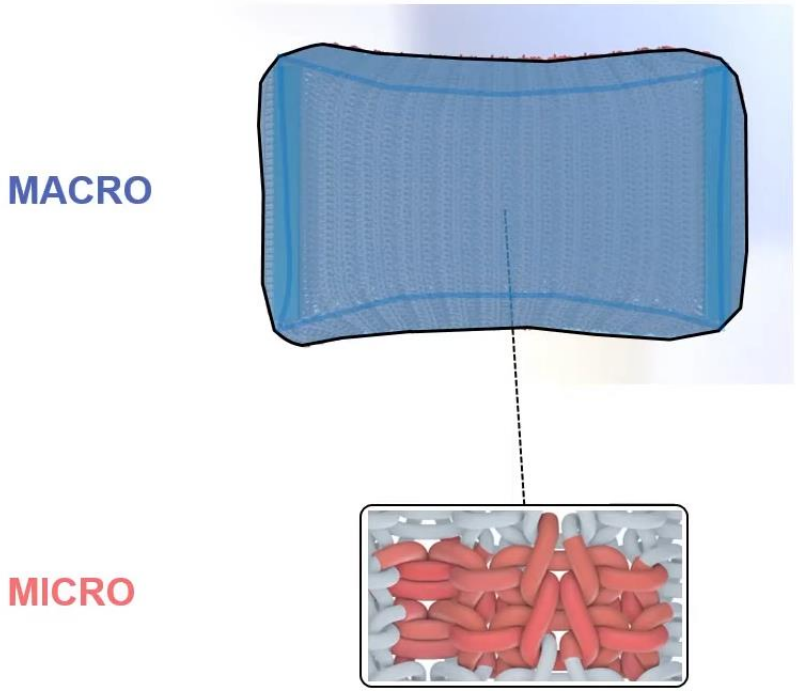
→ Matériau en approximation continu (maillage triangulaire) décrit par une énergie élastique.

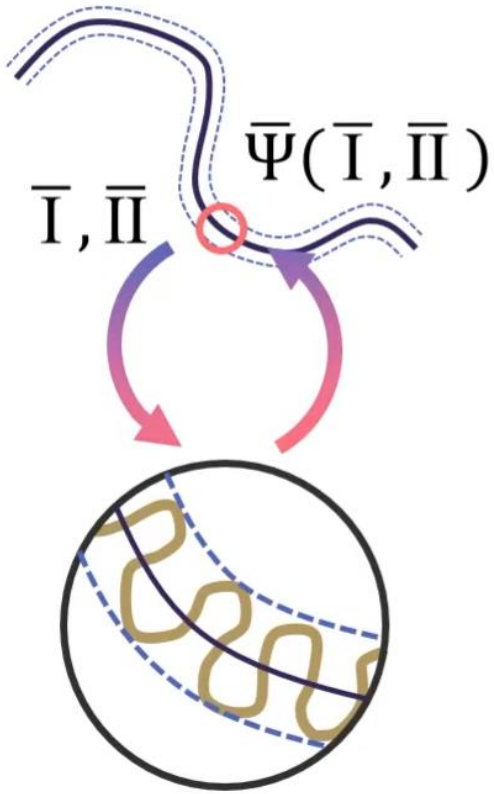
→ Quelle énergie à utiliser?

Homogénéisation



→ Appliquer une déformation macro sur l'échelle micro, calculer l'énergie associée et la « moyenner » pour remonter à l'échelle macro.

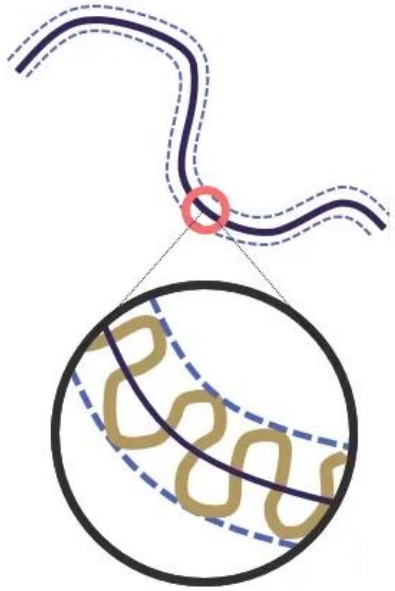




Homogénéisation du tissu au niveau du fil

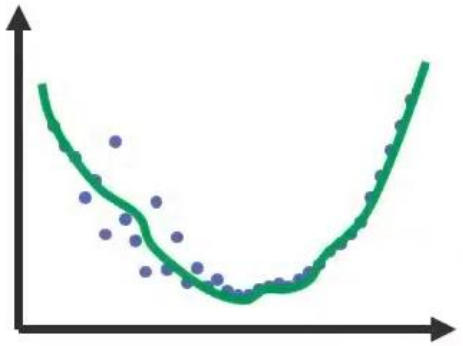
→ Le tissu est périodique! Le Choix de volume élémentaire se base là dessus.

Homogenization



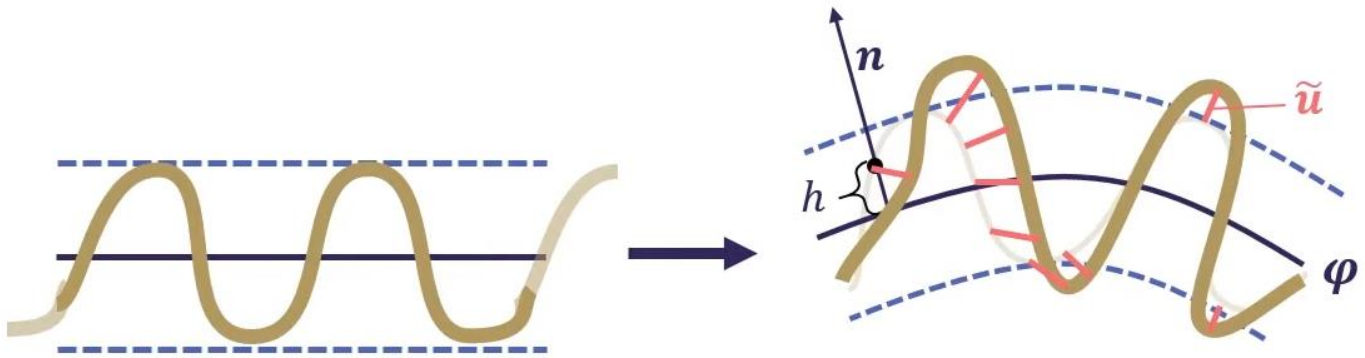
Simulation

Fitting



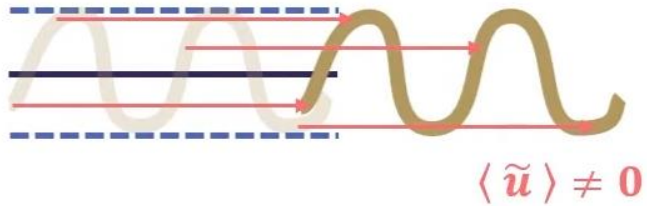
FEM-Cloth

Théorie des plaques minces et homogénéisation

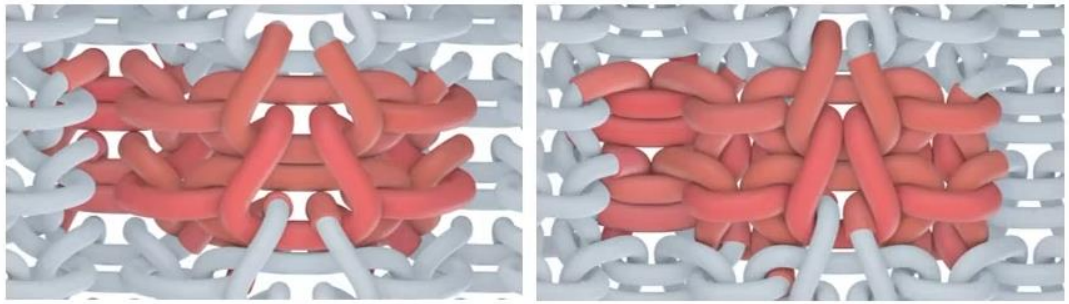


average *

$$\langle \tilde{u} \rangle = 0$$



bulk $\varphi + h\,n$ $+ \tilde{u}$ **fluctuations**



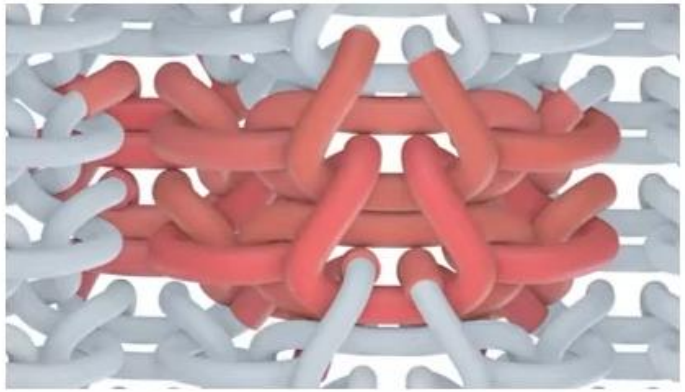
periodicity *

$$\tilde{u}^+ = \tilde{u}^-$$

* Dans un repère aligné à la surface.

Simulations micro-échelle

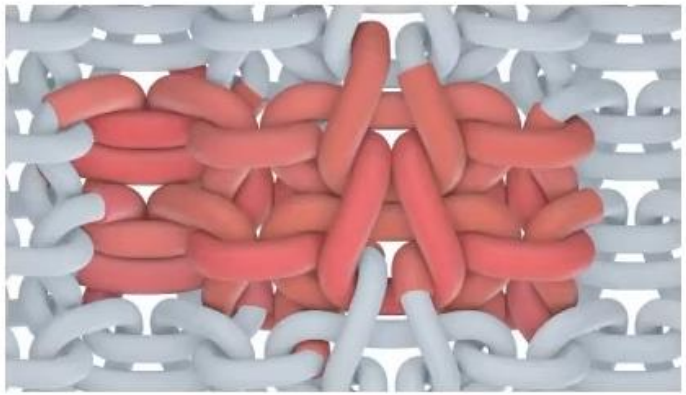
bulk deformation



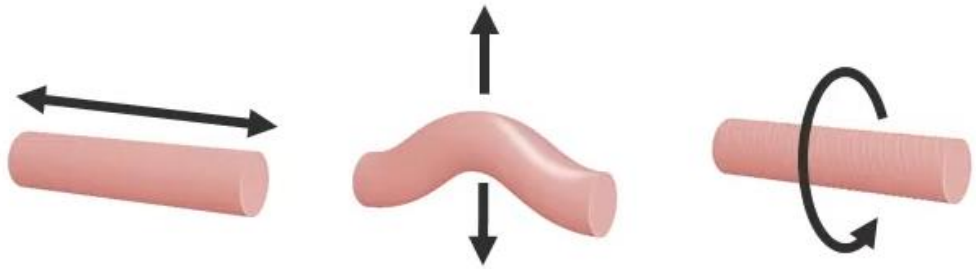
$\tilde{u} = \mathbf{0}$

constrained optimization

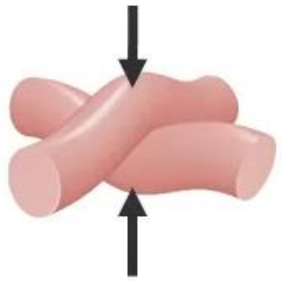
static equilibrium



$\min_{\tilde{u}} E$



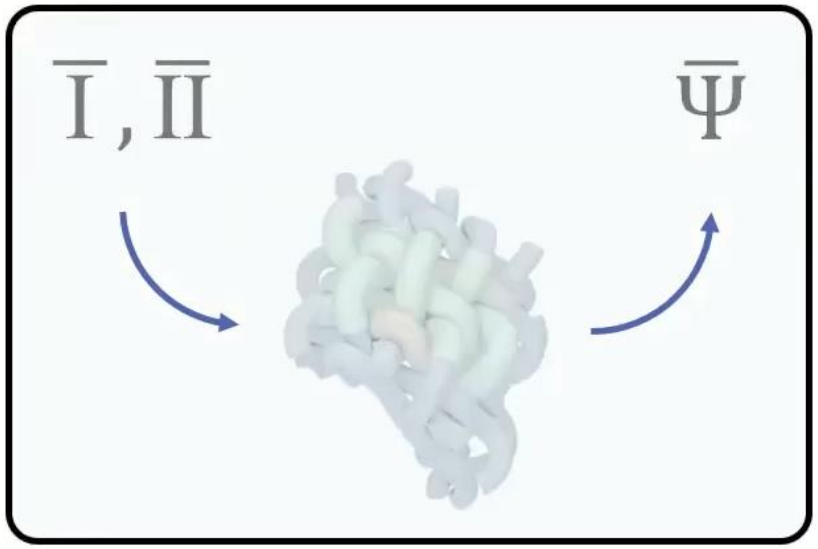
[Bergou et al. 2010]



[Kaldor et al. 2008]

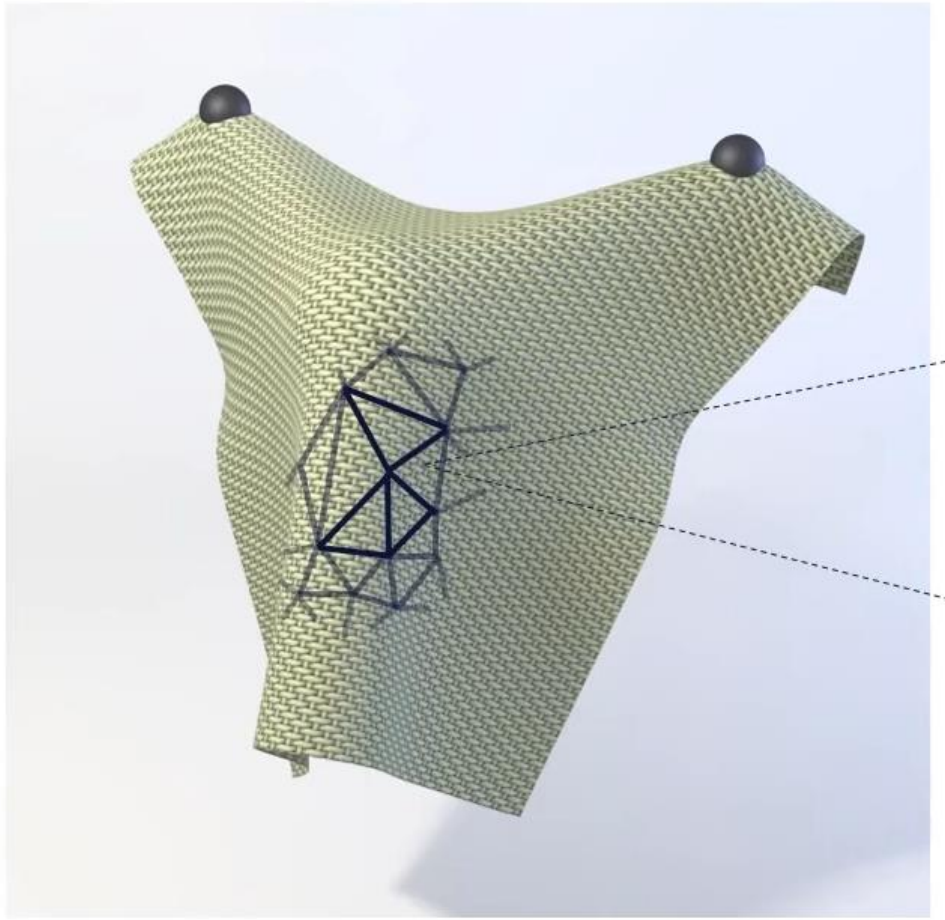
* Pas de friction, hysterisis.

Trouver un modèle paramétrique de l'énérgie



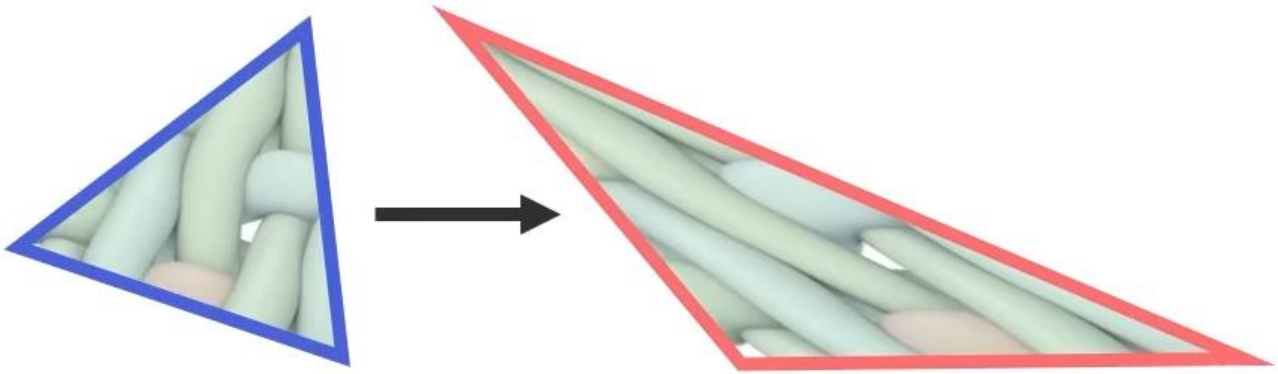
$$\rightsquigarrow \bar{\Psi}(\bar{I}, \bar{II})$$

Simulation FEM

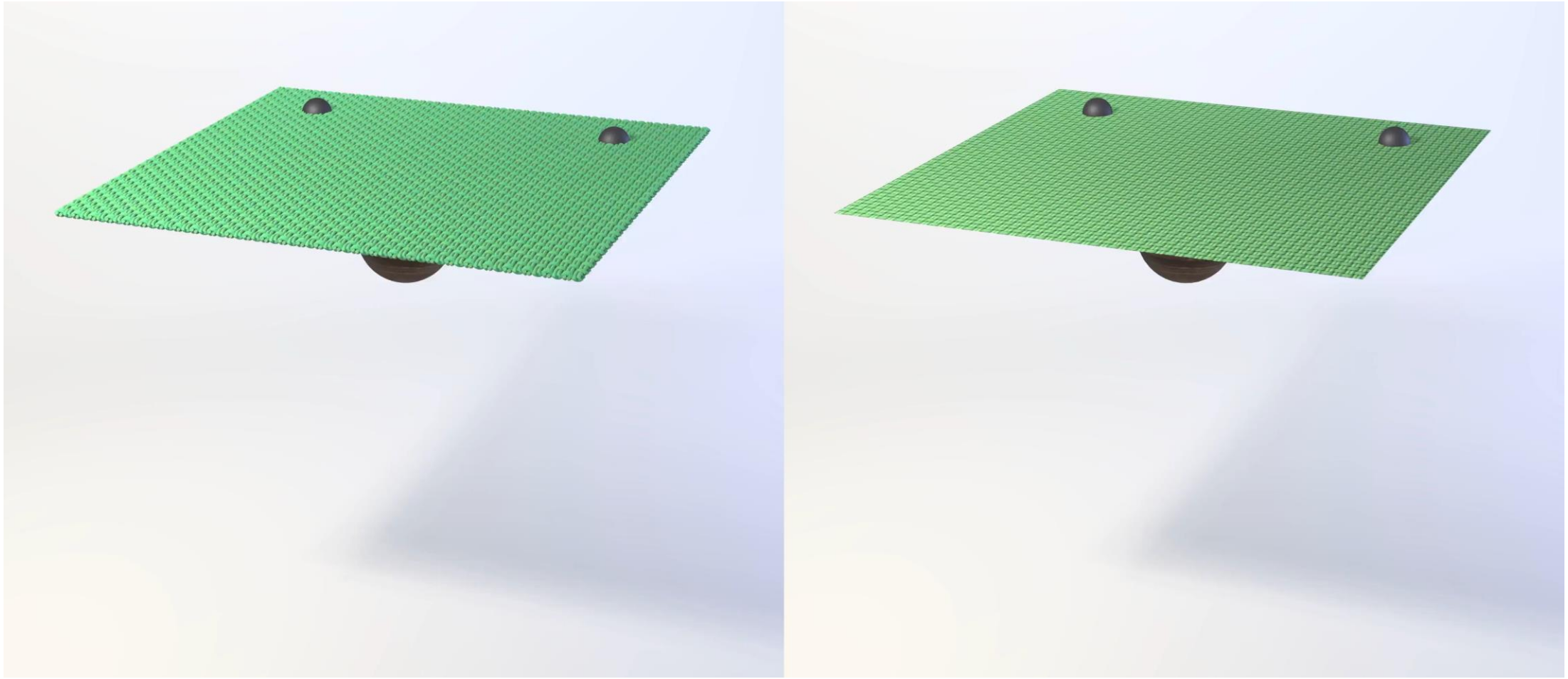


$\bar{\Psi}$

$\bar{I}, \bar{II}$



ARCSim [Narain et al. 2012]



Simulation		HYLC				YLC			
		Δt	sec/step	sec/frame	# Vertices*	Δt	sec/step	sec/frame	# Vertices
basket drape	Fig. 16	2.09e-04	0.46	73.46	2276	1e-05	0.13	(×5.9) 430.43	65188
basket drape 90°		2.09e-04	0.46	72.74	2229	2e-05	0.23	(×5.2) 381.50	65188
basket stretch	Fig. 16	2.09e-04	0.50	80.58	2668	1e-05	0.17	(×7.0) 560.43	65188
basket stretch 90°		2.09e-04	0.52	82.96	2657	1e-05	0.24	(×9.6) 797.10	65188
honey drape	Fig. 16	1.67e-04	0.41	81.91	2091	1e-05	0.36	(×14.7) 1206.40	118140
honey drape 90°		1.28e-04	0.42	109.65	2127	1e-05	0.39	(×12.0) 1314.72	118140
honey stretch	Fig. 16	1.67e-04	0.49	98.67	2370	1e-05	0.31	(×10.3) 1017.60	118140
honey stretch 90°	Fig. 1	1.67e-04	0.44	87.50	2376	1e-05	0.29	(×10.9) 954.20	118140
rib drape		2.09e-04	0.48	76.86	2337	5e-06	0.39	(×34.2) 2625.12	157592
rib drape 90°		2.09e-04	0.48	77.32	2374	5e-06	0.53	(×46.0) 3559.10	157592
rib stretch		2.09e-04	0.48	76.35	2577	5e-06	0.38	(×33.3) 2542.47	157592
rib stretch 90°		2.09e-04	0.47	75.07	2541	5e-06	0.45	(×39.6) 2971.27	157592
satin drape	Fig. 1	2.09e-04	0.48	77.21	2297	1e-05	0.56	(×24.0) 1855.08	95040
satin drape 90°		2.09e-04	0.47	74.74	2246	1e-05	0.56	(×24.9) 1861.55	95040
satin stretch		2.09e-04	0.44	70.82	2500	1e-05	0.35	(×16.6) 1176.50	95040
satin stretch 90°		2.09e-04	0.50	79.66	2684	1e-05	0.30	(×12.4) 985.17	95040
stock. drape	Fig. 16	2.09e-04	0.96	152.96	3390	1e-05	0.19	(×4.2) 643.08	76156
stock. drape 90°		2.09e-04	1.03	165.04	3383	4e-06	0.08	(×4.0) 652.35	76156
stock. stretch	Fig. 16	2.09e-04	1.15	184.17	4415	1e-05	0.18	(×3.3) 615.83	76156
stock. stretch 90°		2.09e-04	0.79	126.91	3869	4e-06	0.08	(×5.4) 684.30	76156