



Stretchable and bendable (tactile) sensors
Future of interaction symposium 25/02/2016

Steven NAGELS



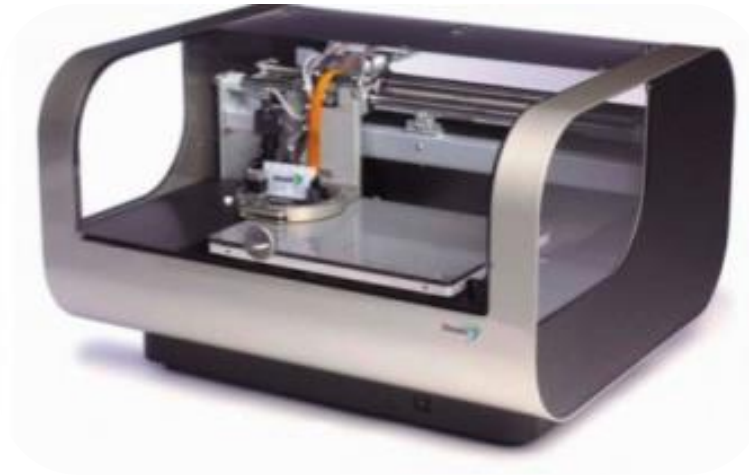
IMO - IMOMEC
INSTITUUT VOOR MATERIAALONDERZOEK

Instituut voor Materiaal Onderzoek (IMO)



Functional Materials Engineering group

- Key interests
 - What materials?
 - On which substrates?
 - Towards which applications?





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Relevance of stretchable and bendable (tactile) sensors

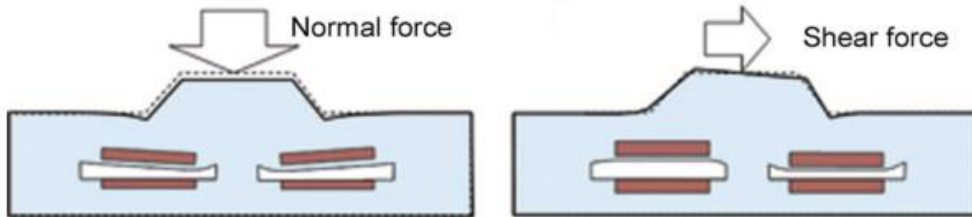
- New HCI design possibilities
- Wearable sensors – sensor suits and patches
- Human like robotic tactile feedback
 - Machine learning
 - Human-like touch



(Rendl et al., 2014)



(Büscher et al., 2015)

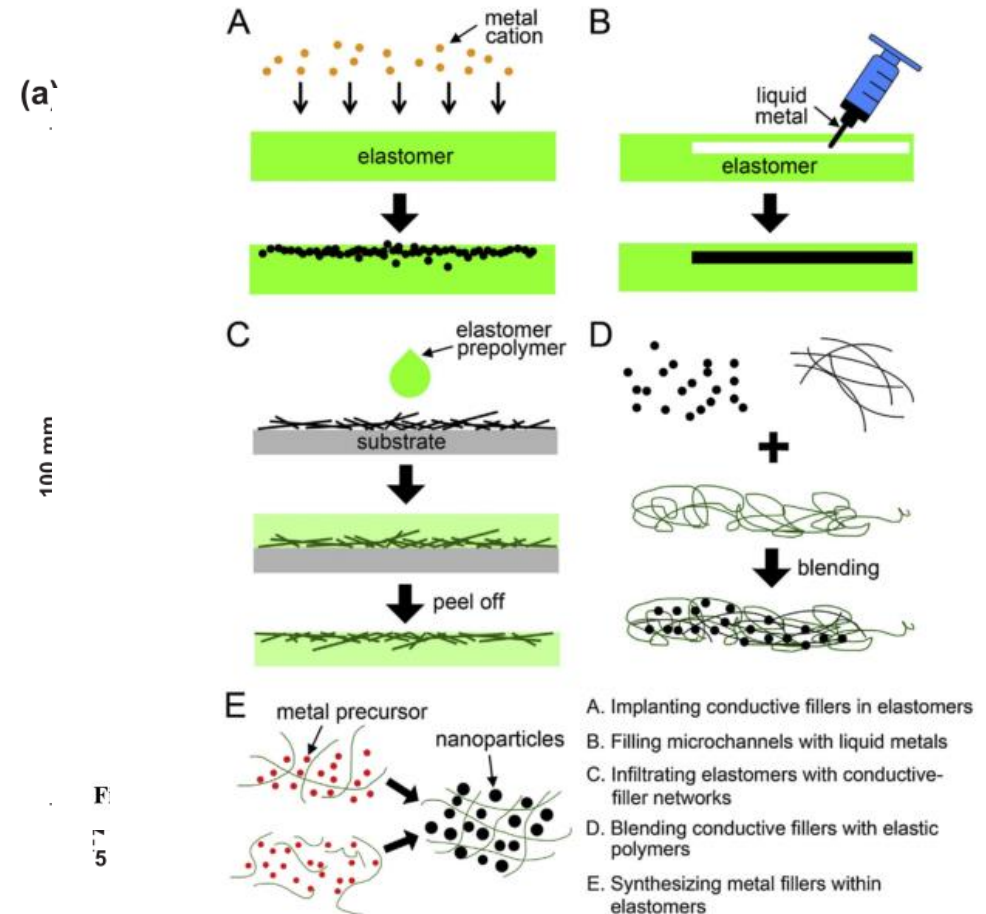


(Yousef et al., 2011)



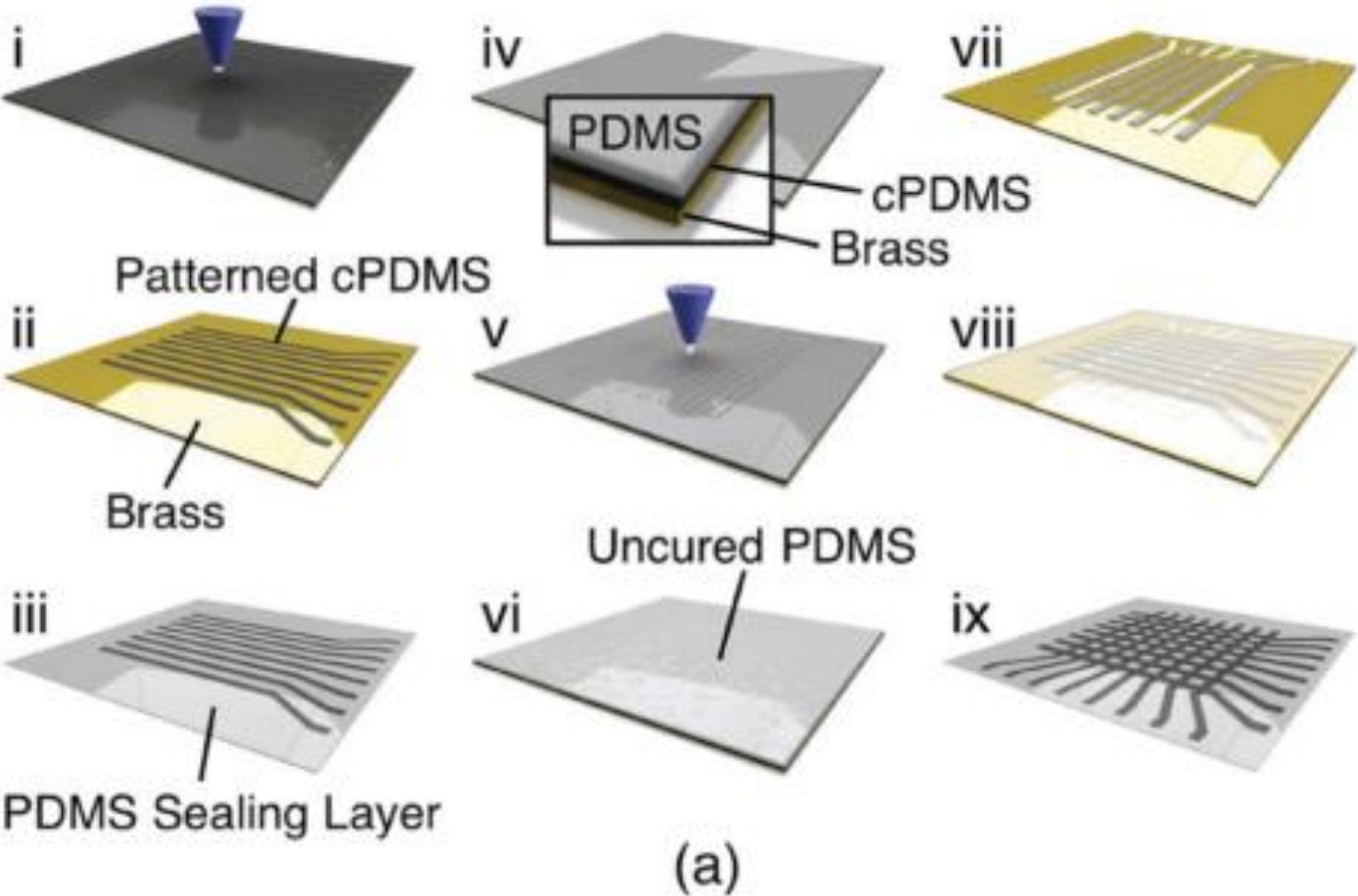
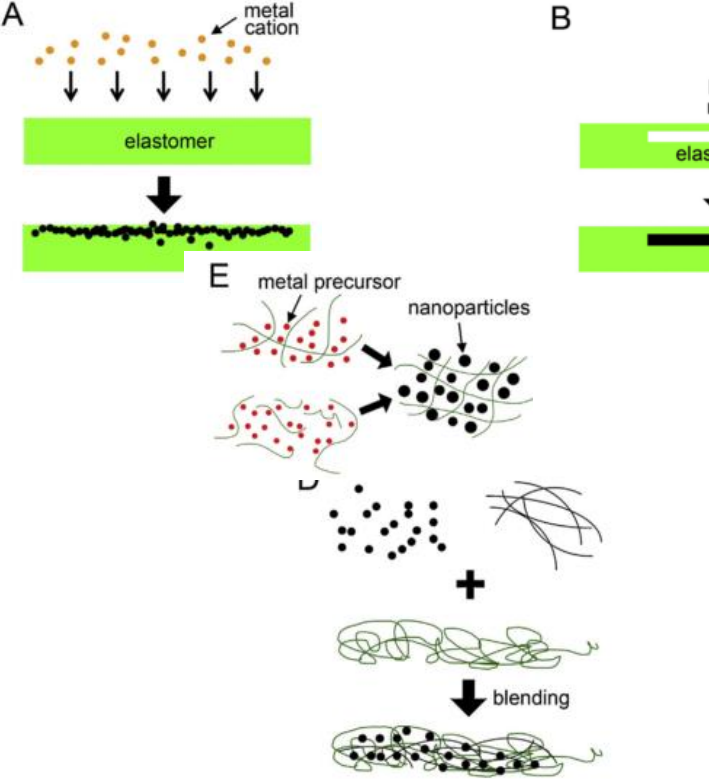
Main technologies to obtain stretching properties

- Adapt conducting material
- Adapt (printed) pattern
- Apply pre-tension

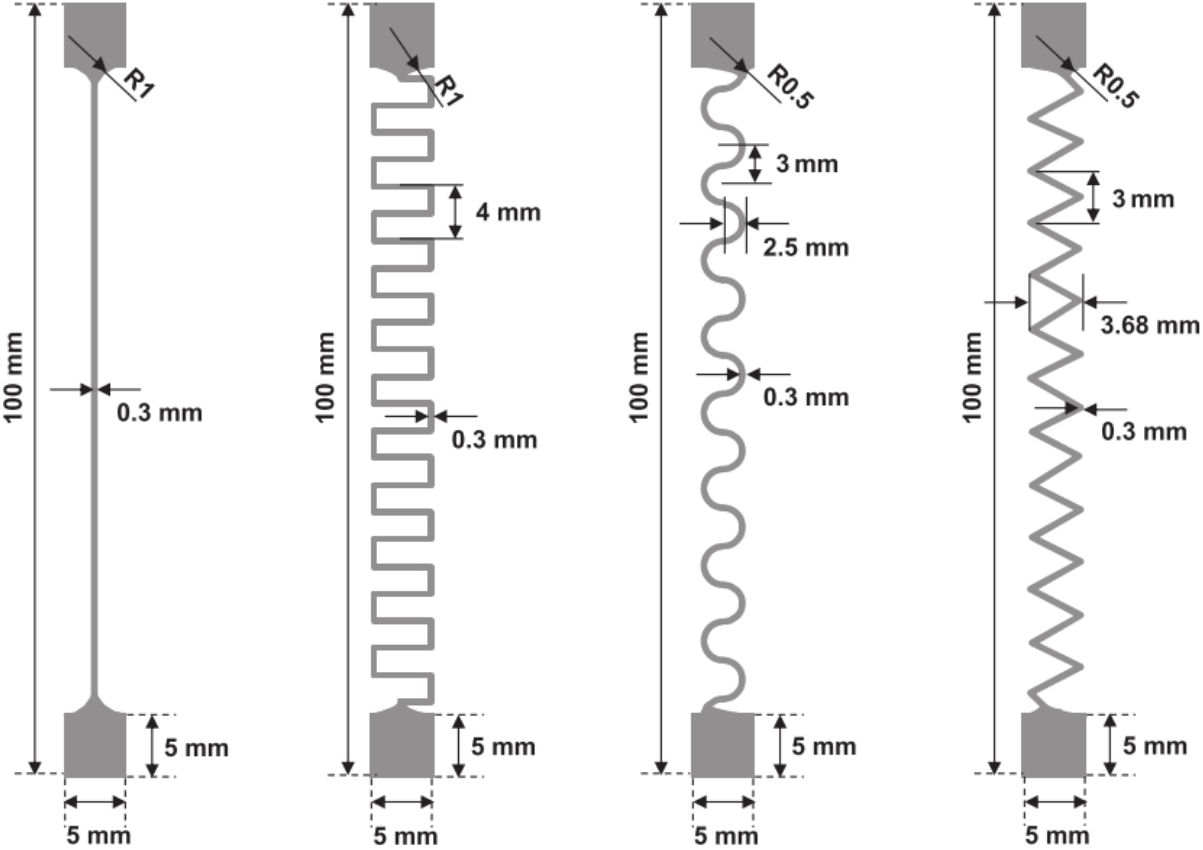
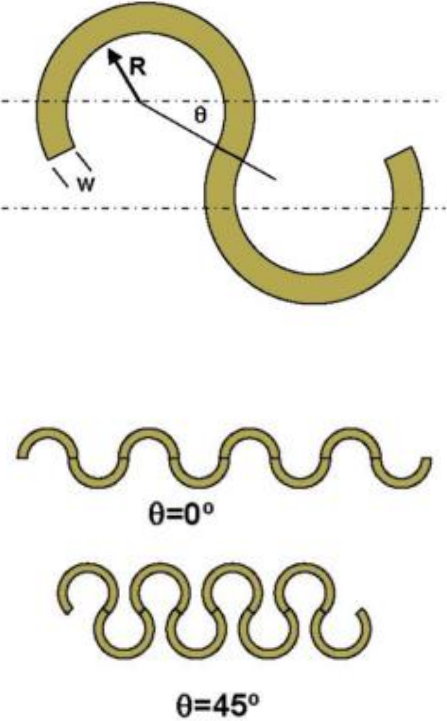


ate.

Adapt conducting material



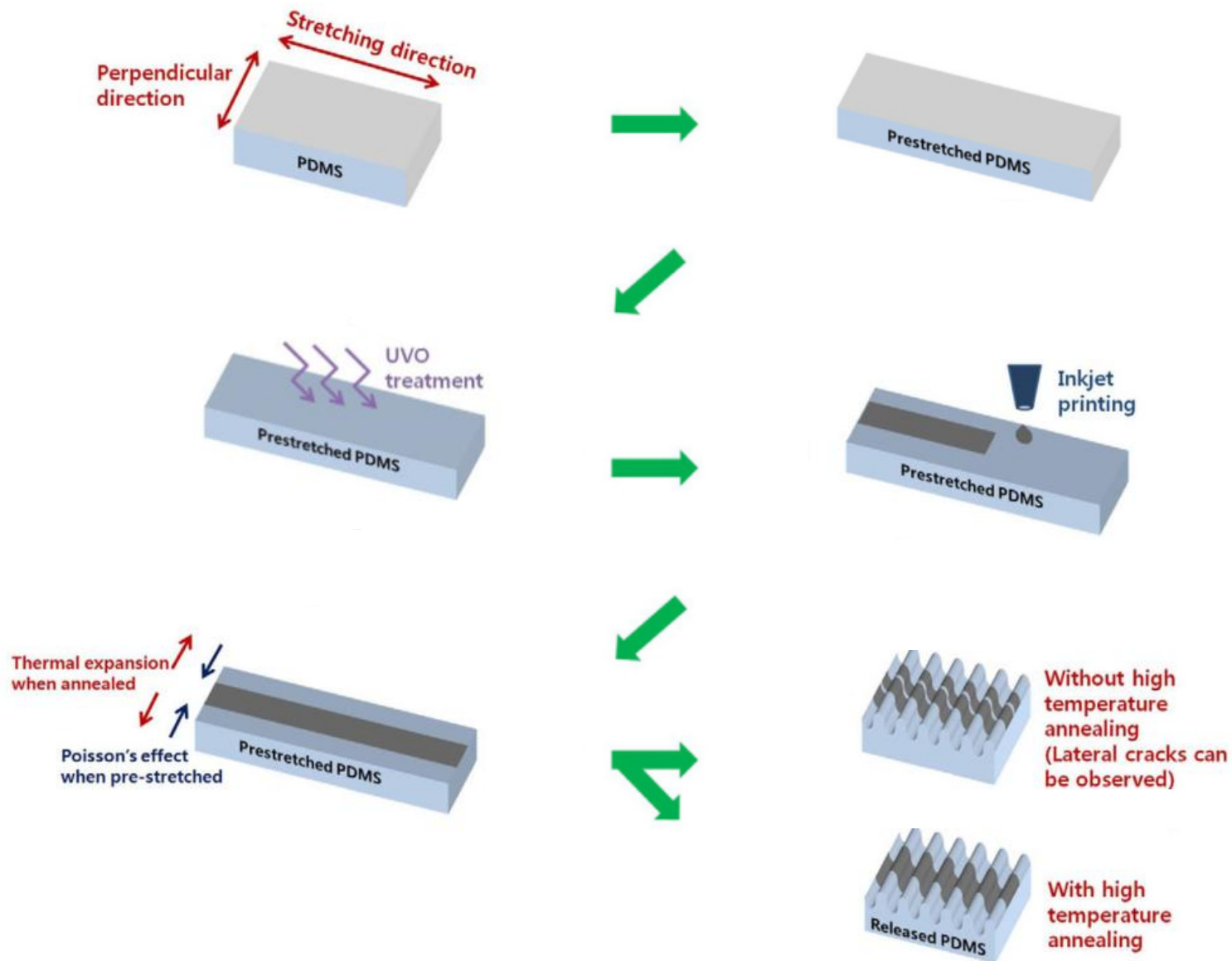
Adapt printed pattern



(Gonzalez et al., 2007)

(Kim et al., 2014)

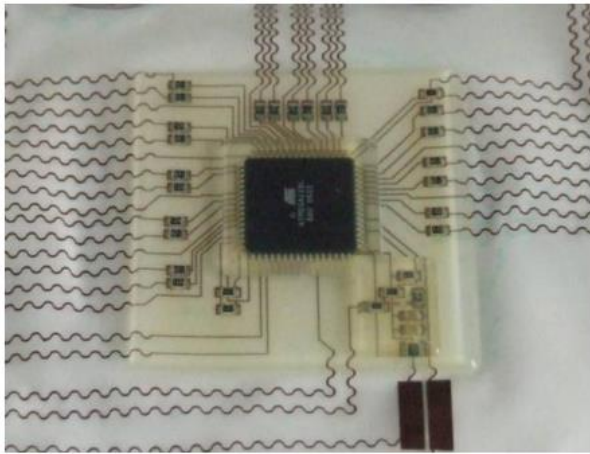
Apply pre-tension



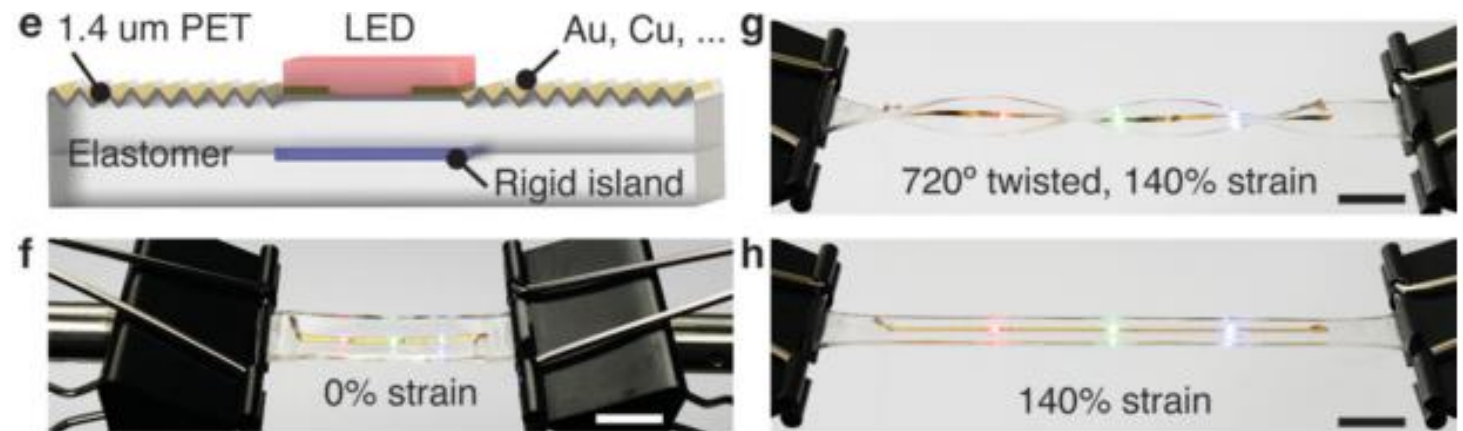
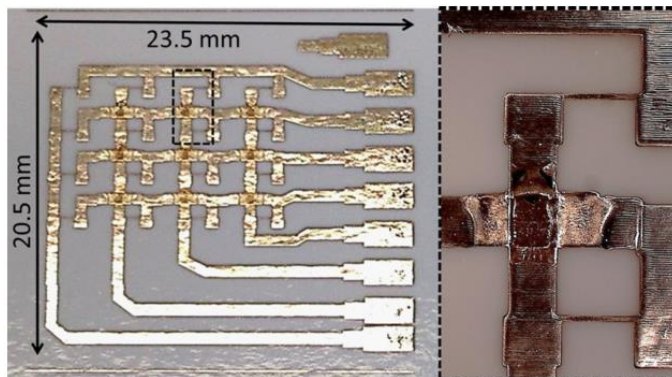
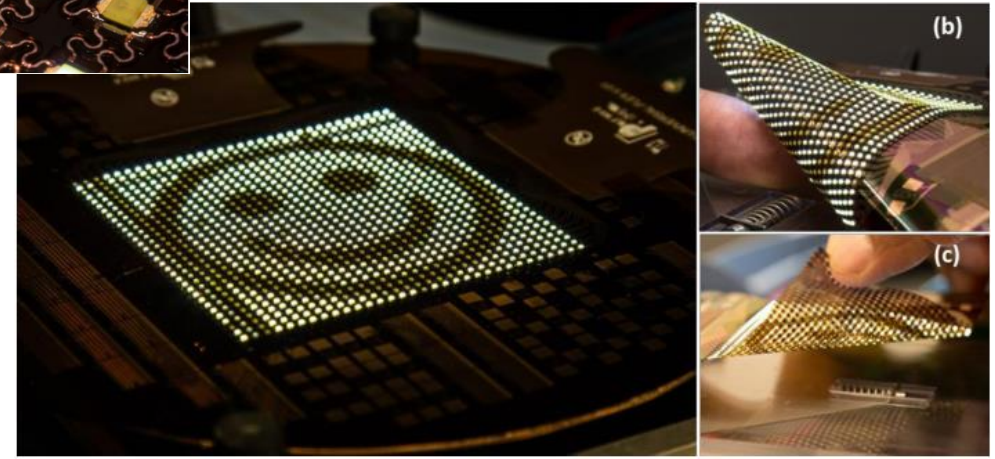
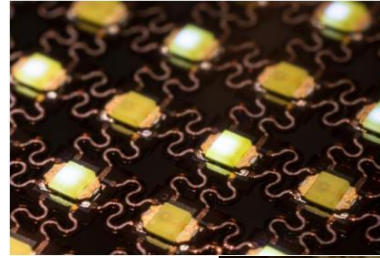
(Lee, Chung et al., 2013)

From single paths to fully functioning stretchable electronics

- Strain gradients prevent circuit failure



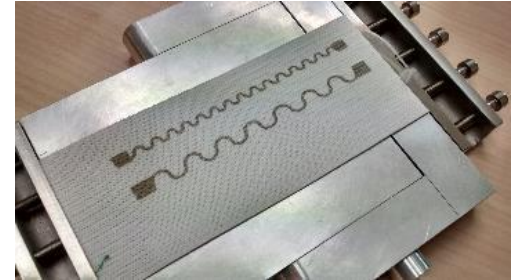
Demonstrators of other groups



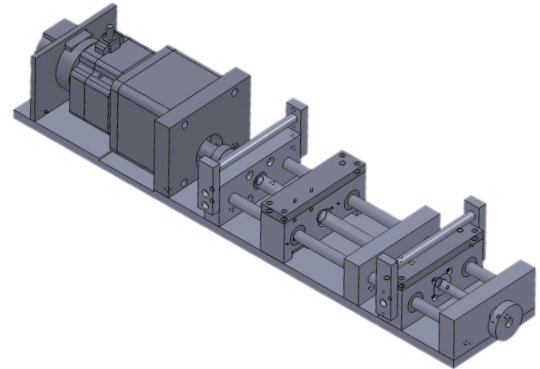
- Achieve stretchability through
 - Adapted commercial screen pastes
 - Adapted pattern designs
 - Applying pre-stretch

- Proprietary devices

- Pre-stretching device



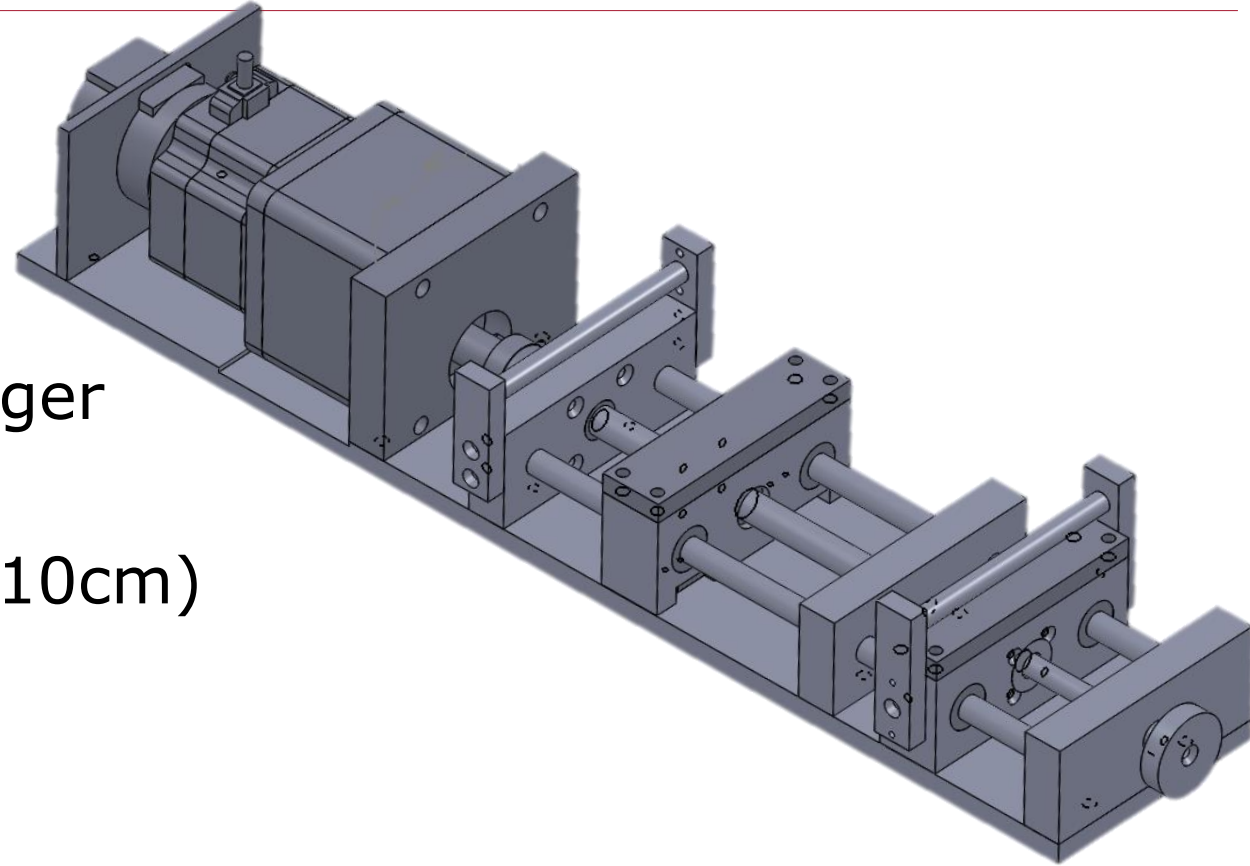
- Stretch test bench



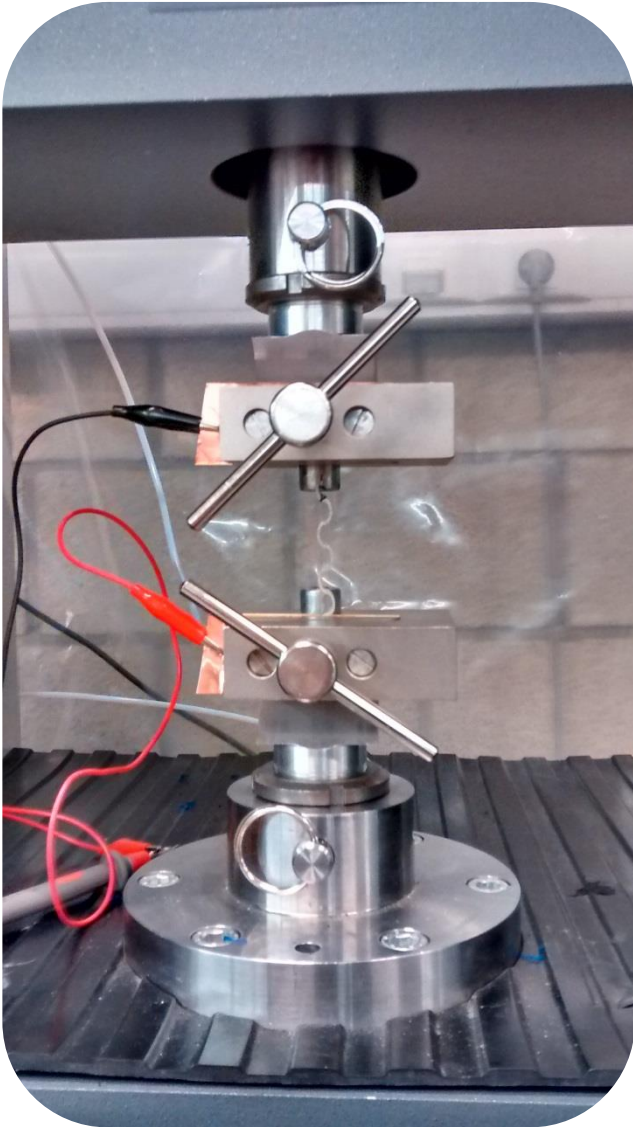
- Pre-stretching device
 - To create buckled stretchables
 - Stretch substrate = top layer
 - Fixed stretched length



- Stretch test bench
 - Extensometer + resistance logger
 - 200% elongation (samples < 10cm)
 - Strong clamping force
 - ~2kN pulling strength

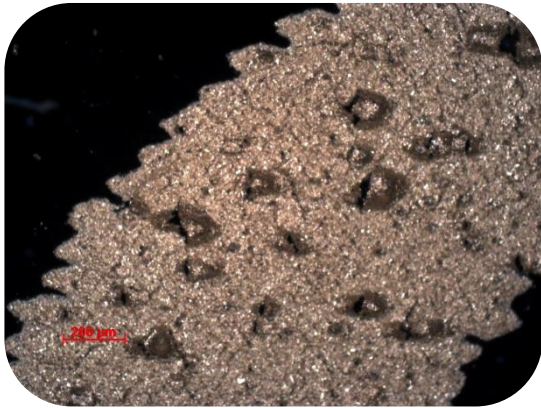
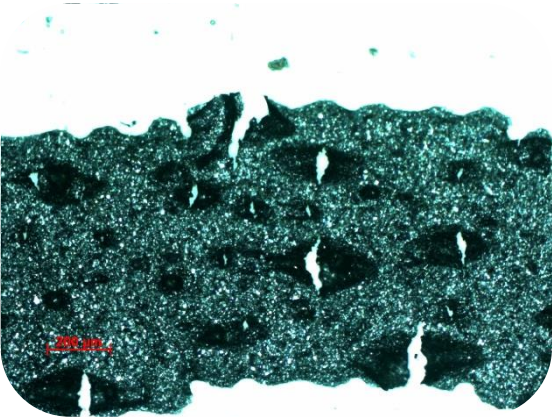


Adapted screen paste results

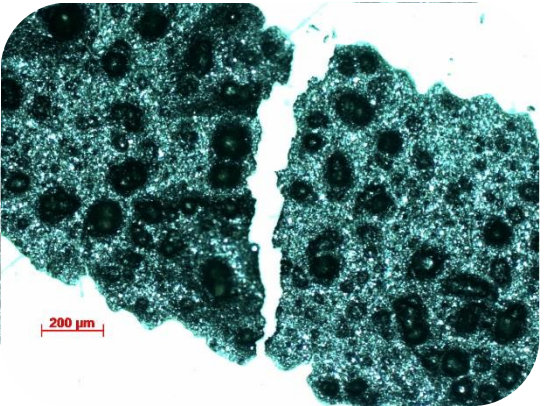


- Adding elastomer
 - Increases initial resistance
 - Decreases resistance growth
 - Introduces flaking
 - Introduces inhomogenities

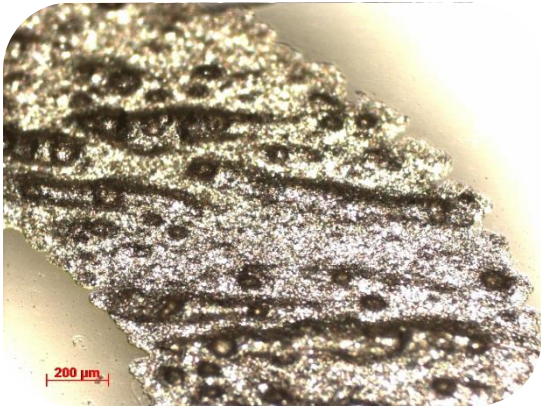
Adapted screen paste results



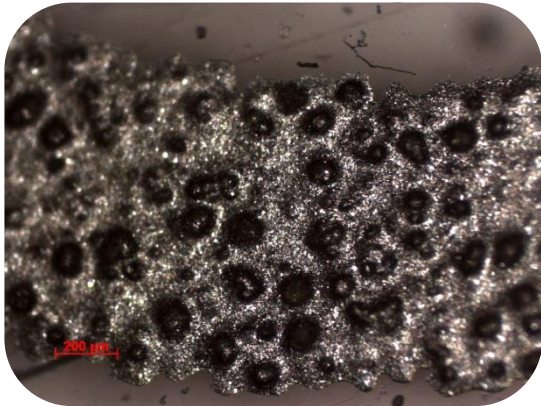
5wt%



25wt% acr



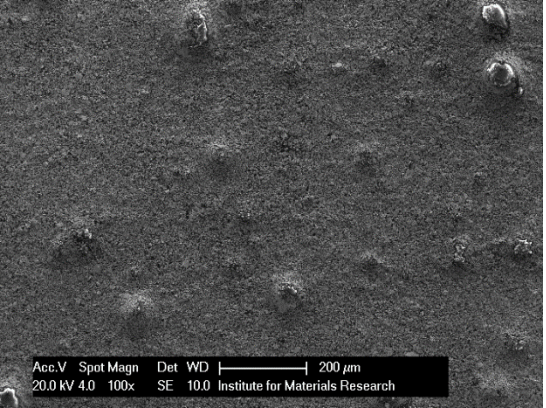
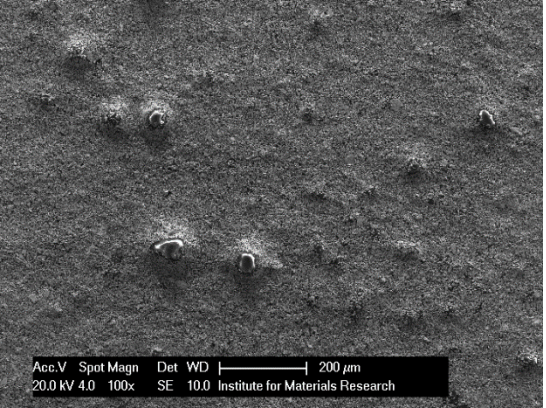
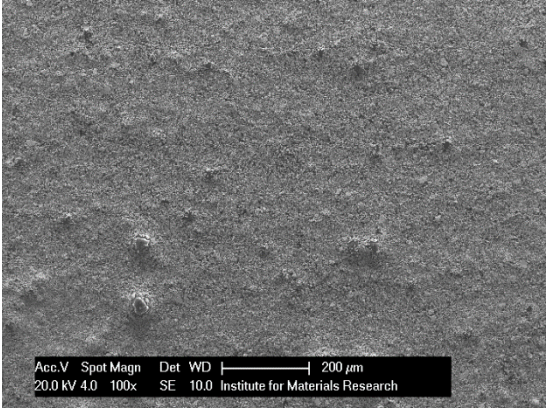
35wt% acr



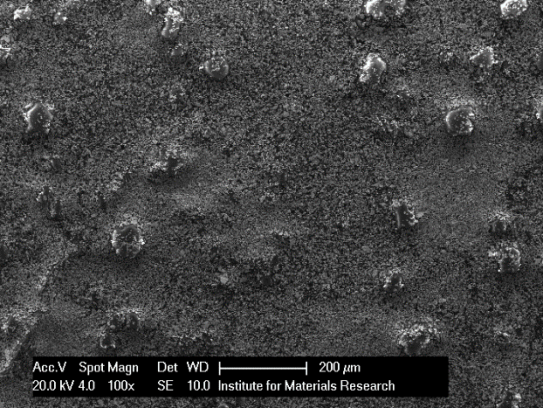
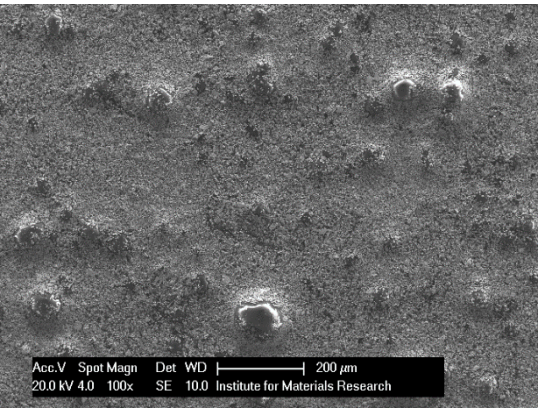
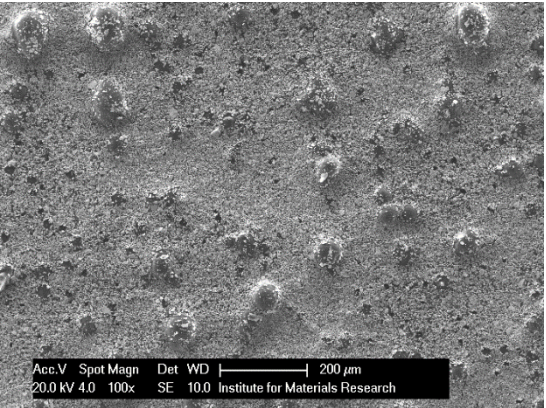
20wt%

45wt% acr

Adapted screen paste results



5wt%



20wt%

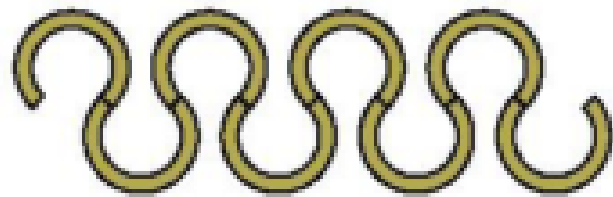
25wt% acr

35wt% acr

45wt% acr

Adapted pattern designs results

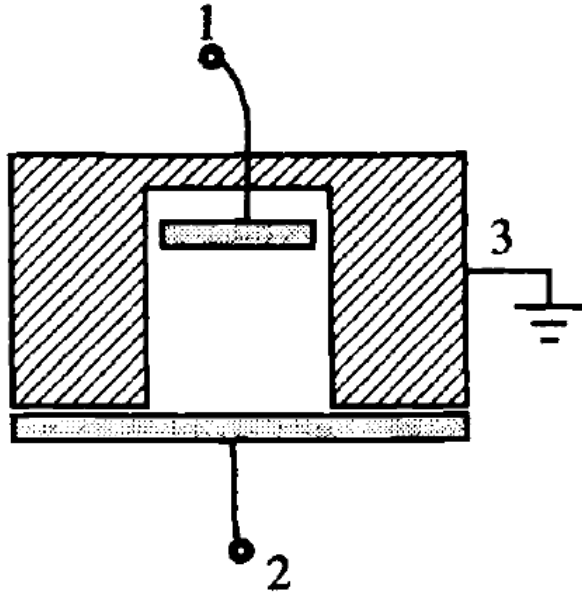
- No real distinction for tested patterns within observed elongation range (0-10%)



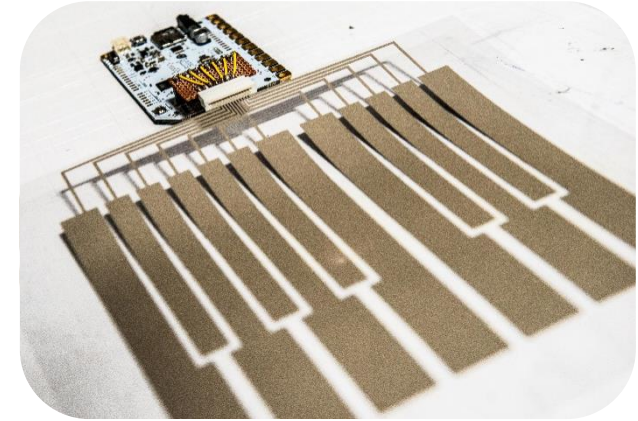
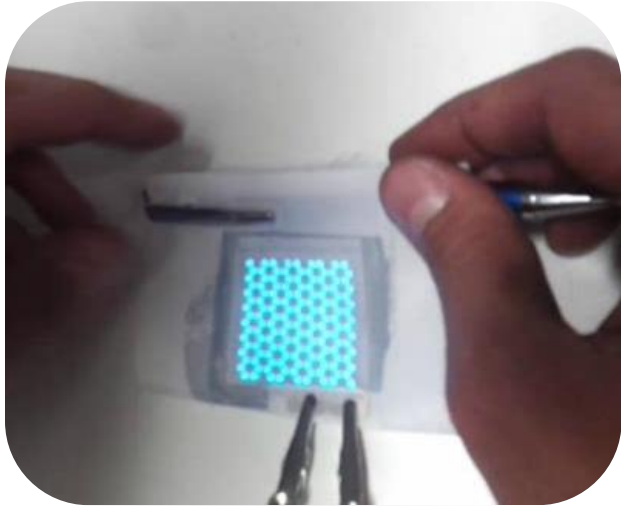
vs



- Shielding theory and preliminary tests



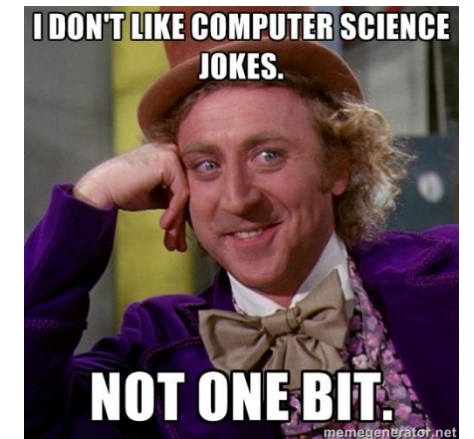
Demonstrators



Future work

- Continue on elastomer screen paste enhancement
- Stretch printed patterns on TPU foil
- Create and stretch sensor arrays

Questions?



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