

Electrical Potentials Observed During Frictional Stick-Slip: A Semiconductor Mechanism

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M.M. Scuderi
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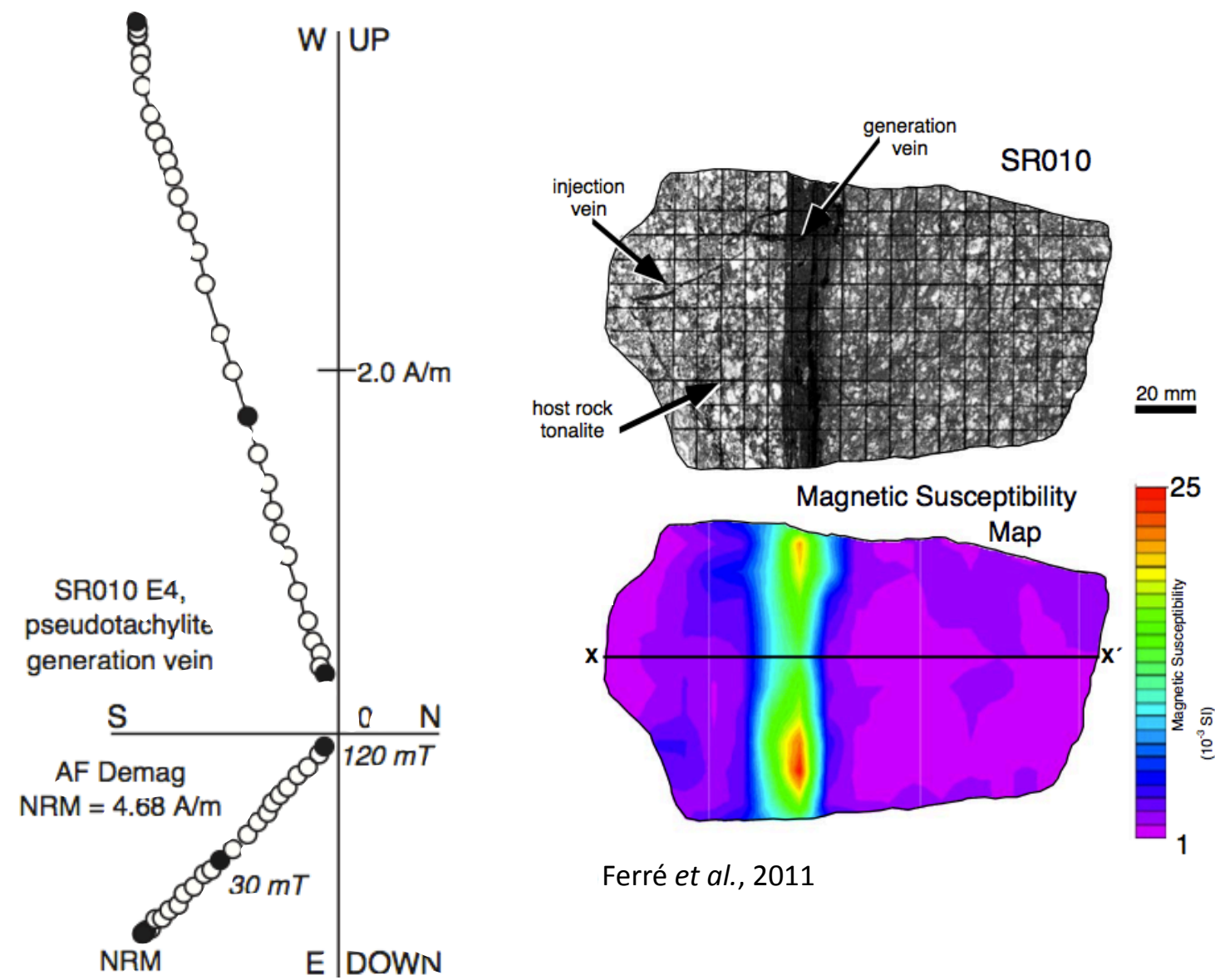
Thank you:
Troy Shinbrot
Brenden Heidrich

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The Pennsylvania State University

December 12, 2013



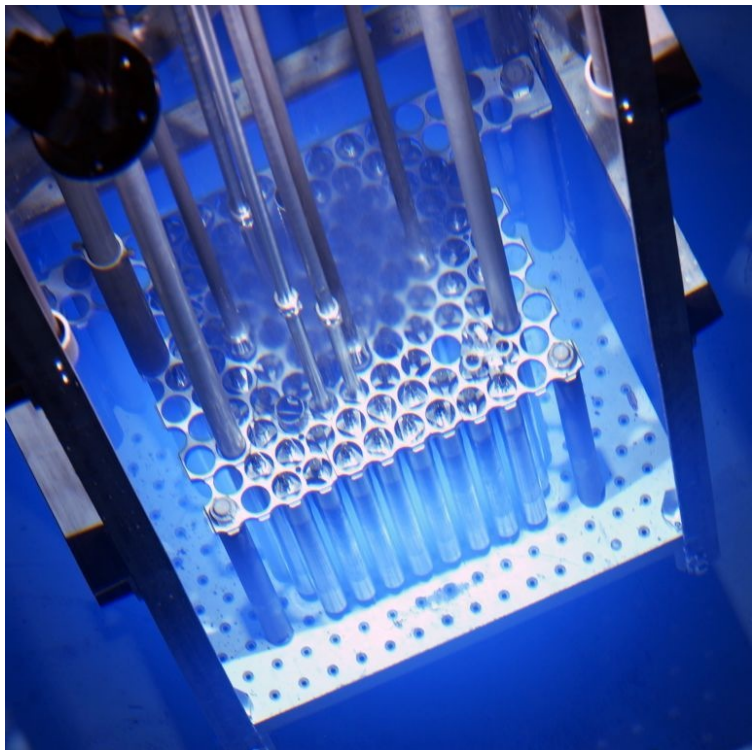
This work begins to systematically study seismo-electrical phenomena and their source mechanisms



Natural Observations

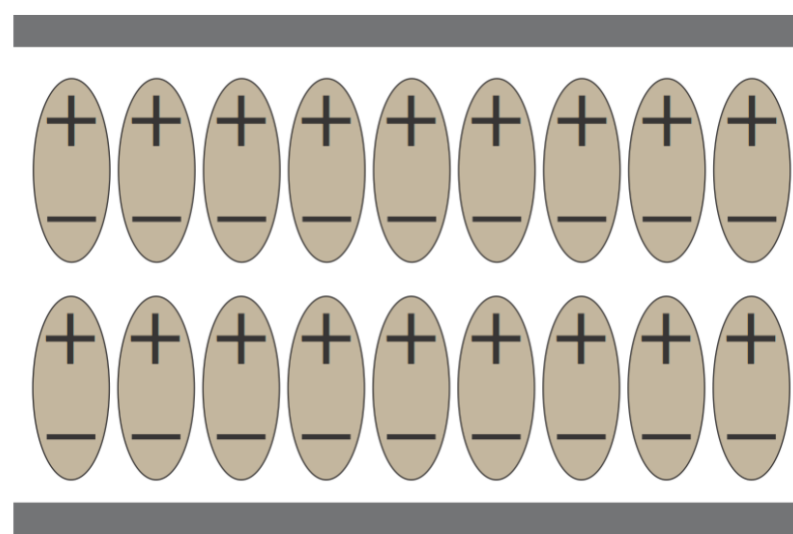


Laboratory Experiments

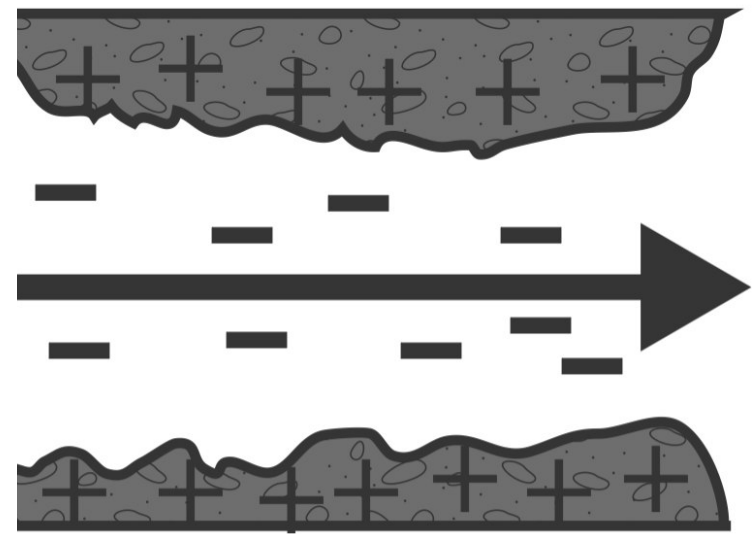


Proposed Work

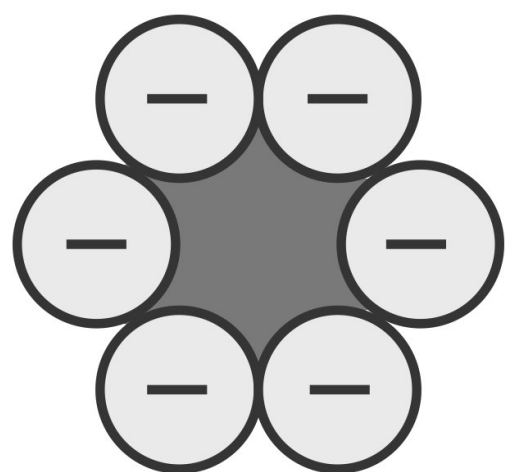
Charge may come from a variety of geologically relevant mechanisms.



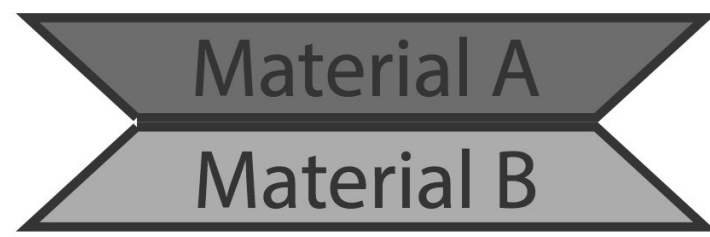
Piezoelectricity



Streaming Potentials

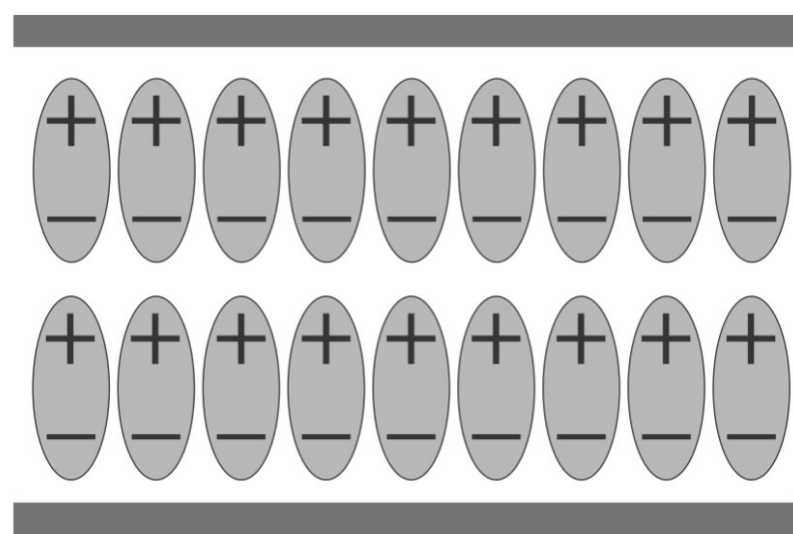


Semi-conductor Effects

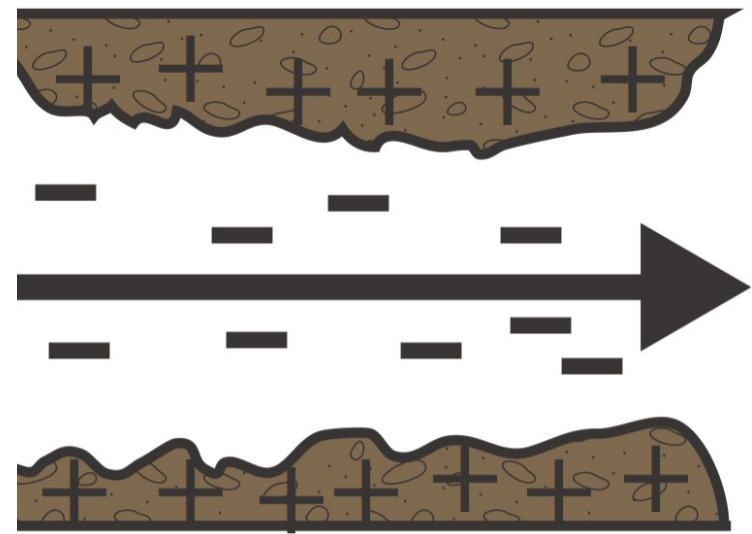


Contact/Tribo Electrification

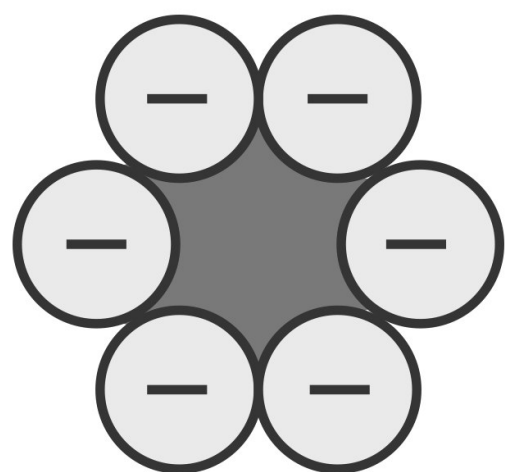
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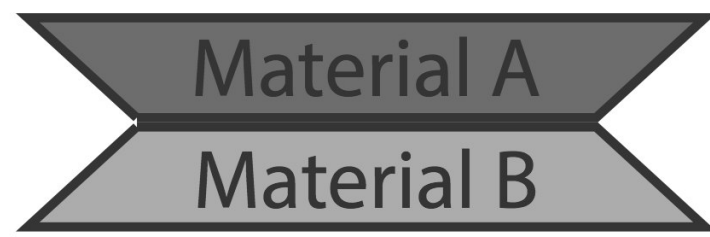
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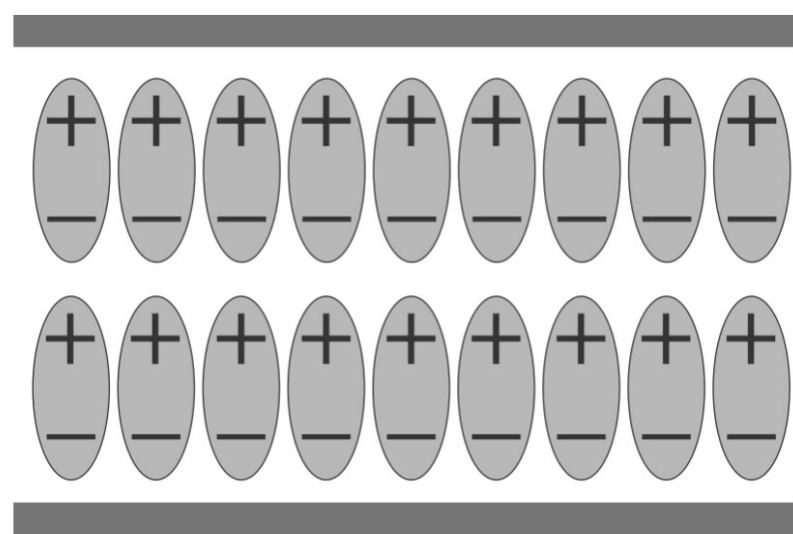


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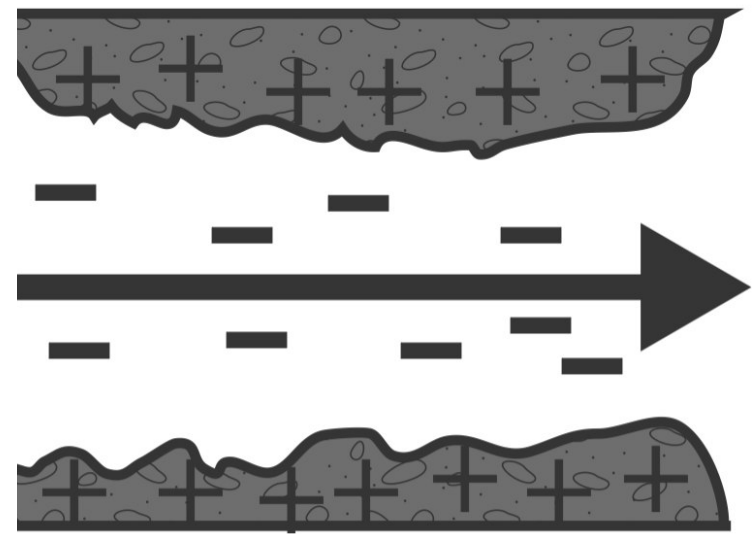


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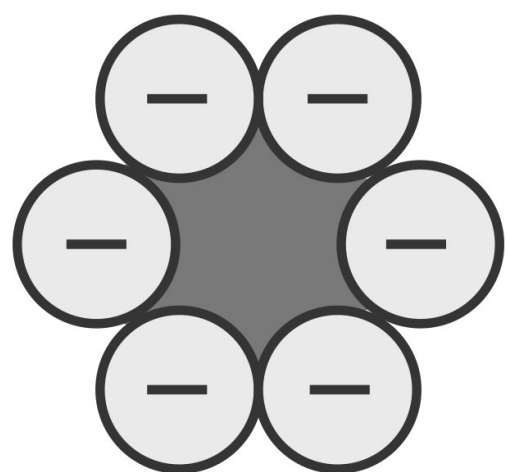
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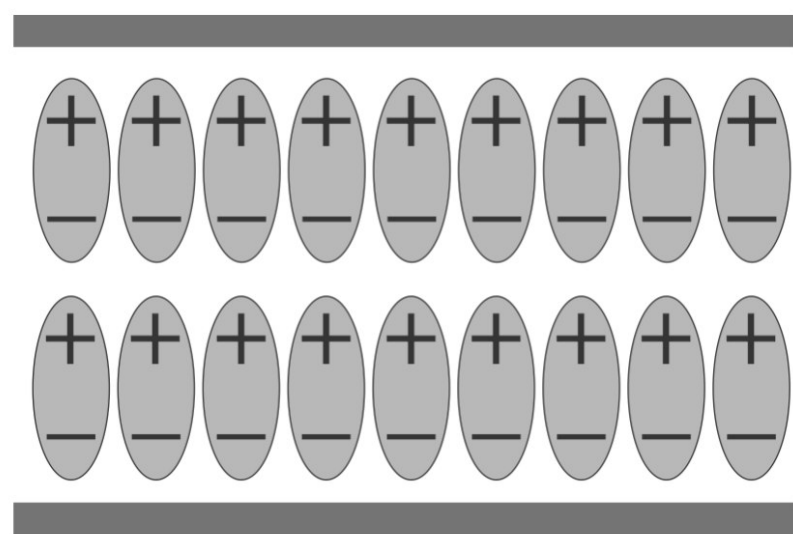


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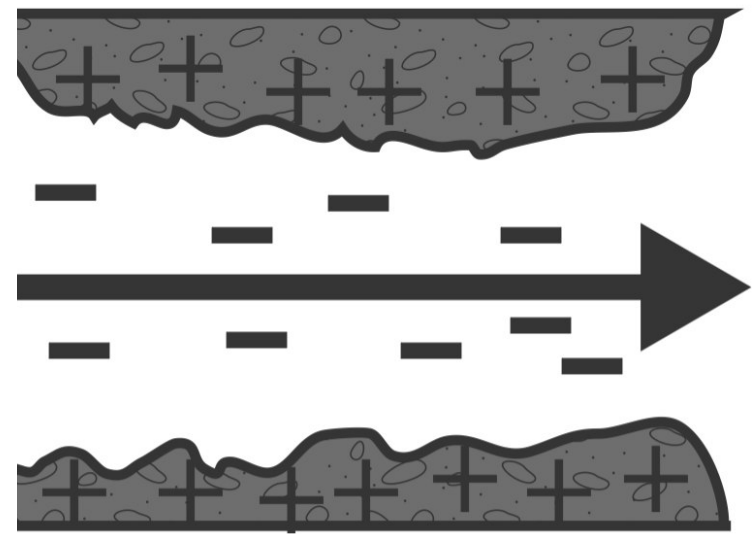


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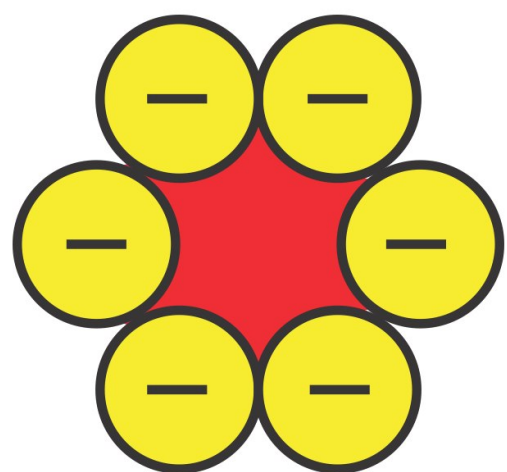
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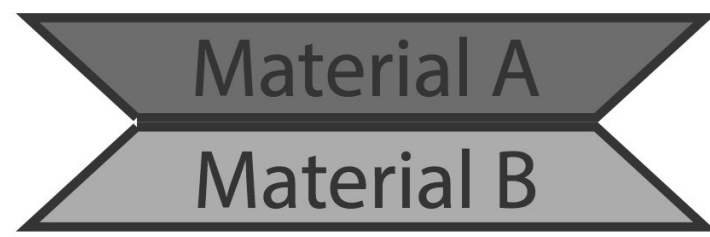
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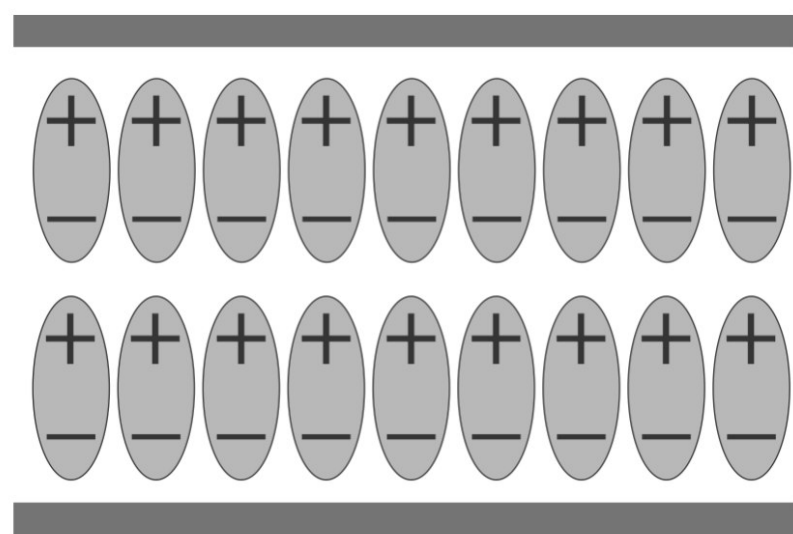


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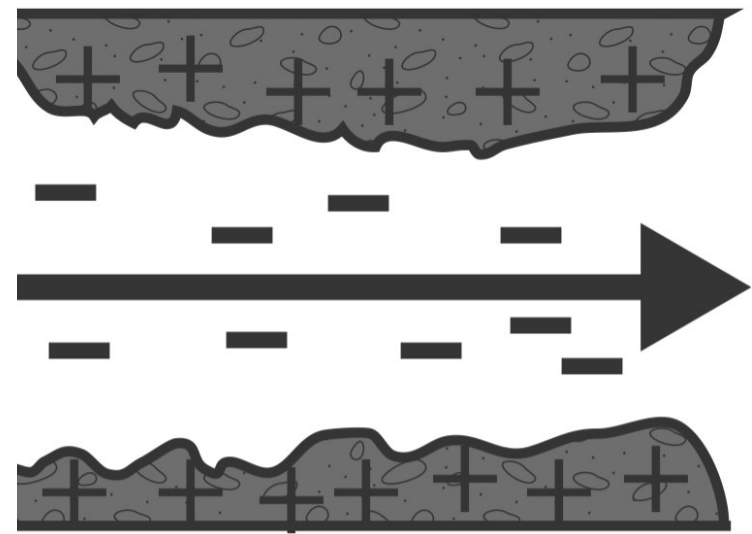


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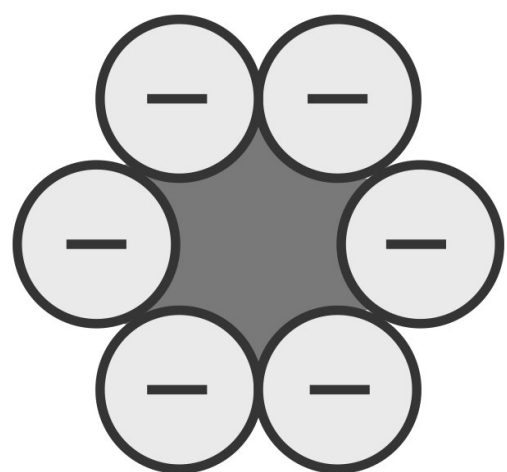
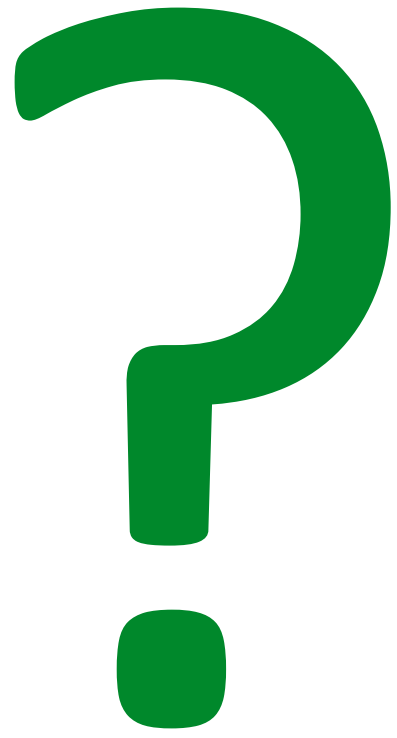
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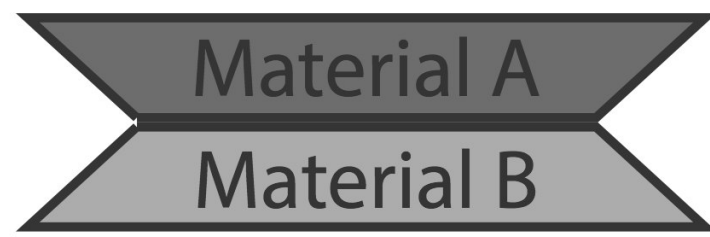
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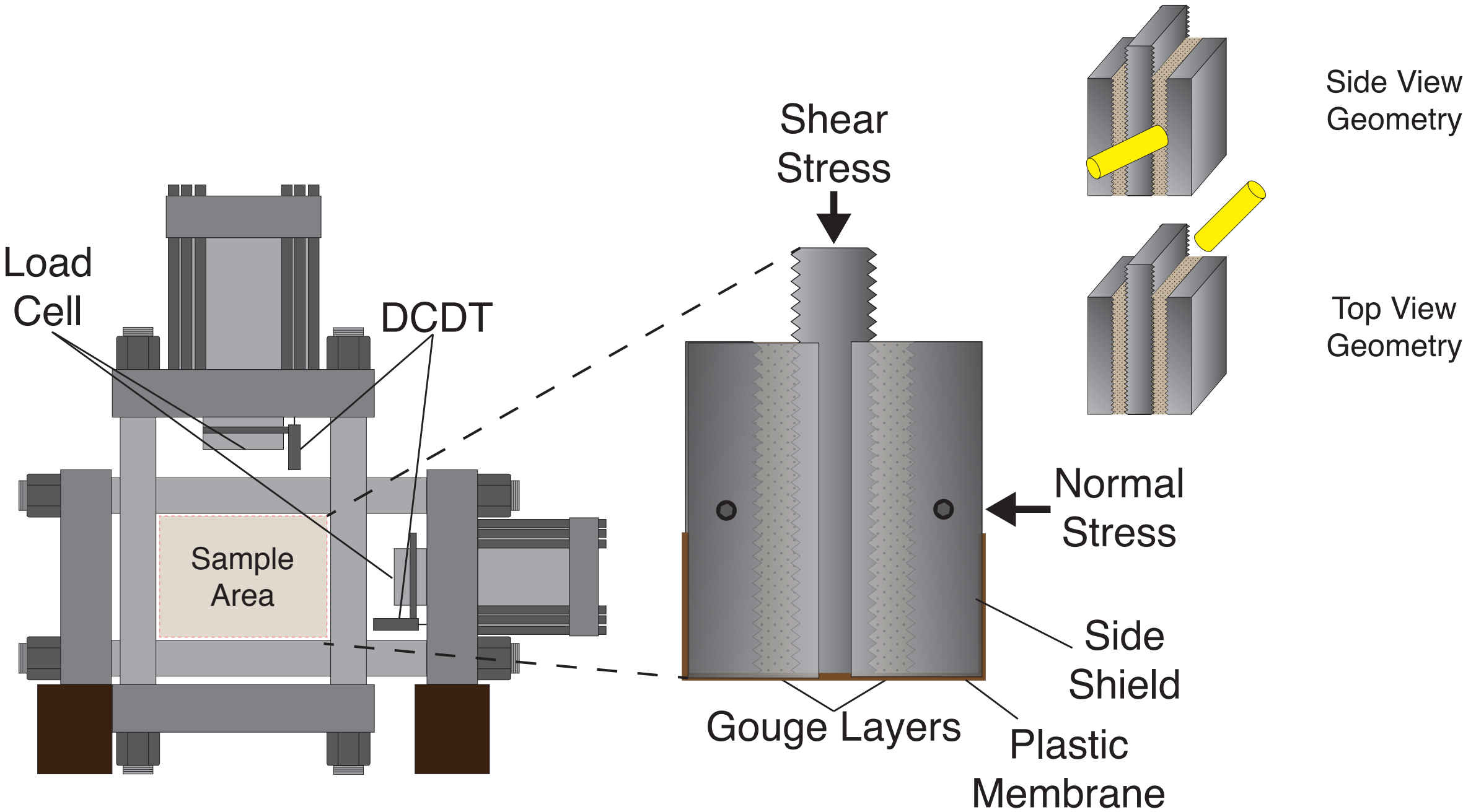


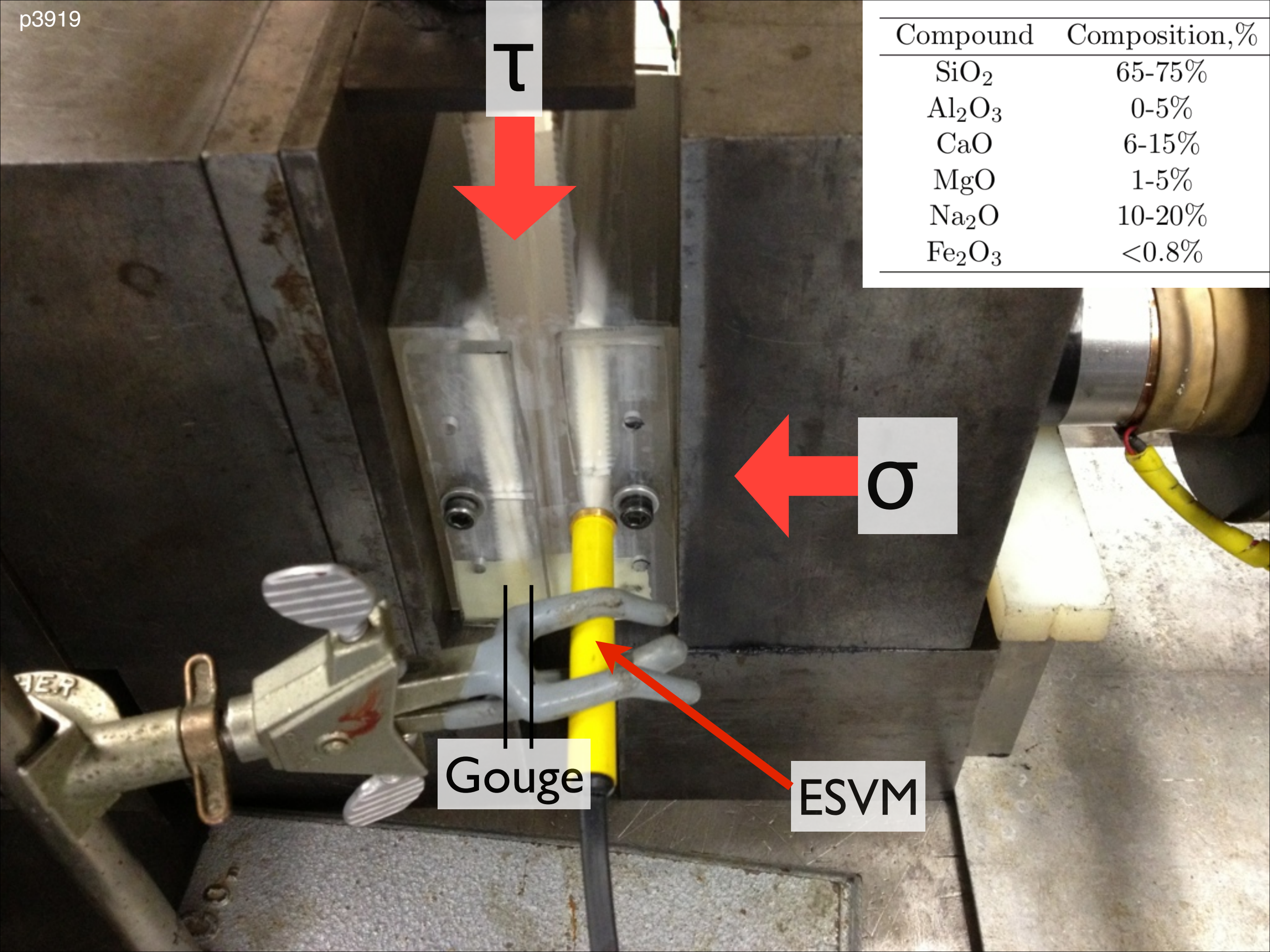
Semi-conductor Effects



Contact/Tribo Electrification

Tests have been conducted with DDS geometry and a no-contact voltage probe.



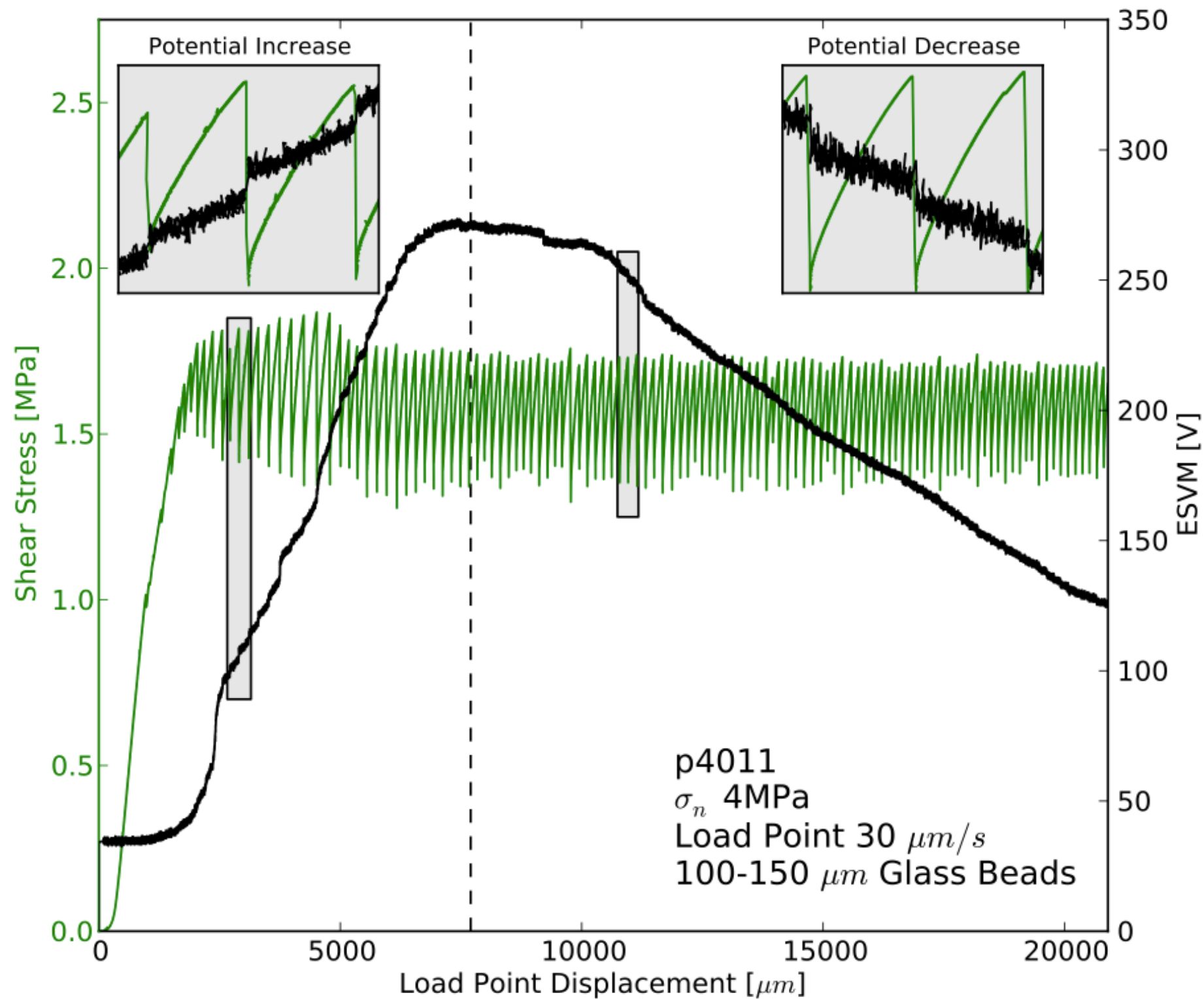


Compound	Composition, %
SiO ₂	65-75%
Al ₂ O ₃	0-5%
CaO	6-15%
MgO	1-5%
Na ₂ O	10-20%
Fe ₂ O ₃	<0.8%

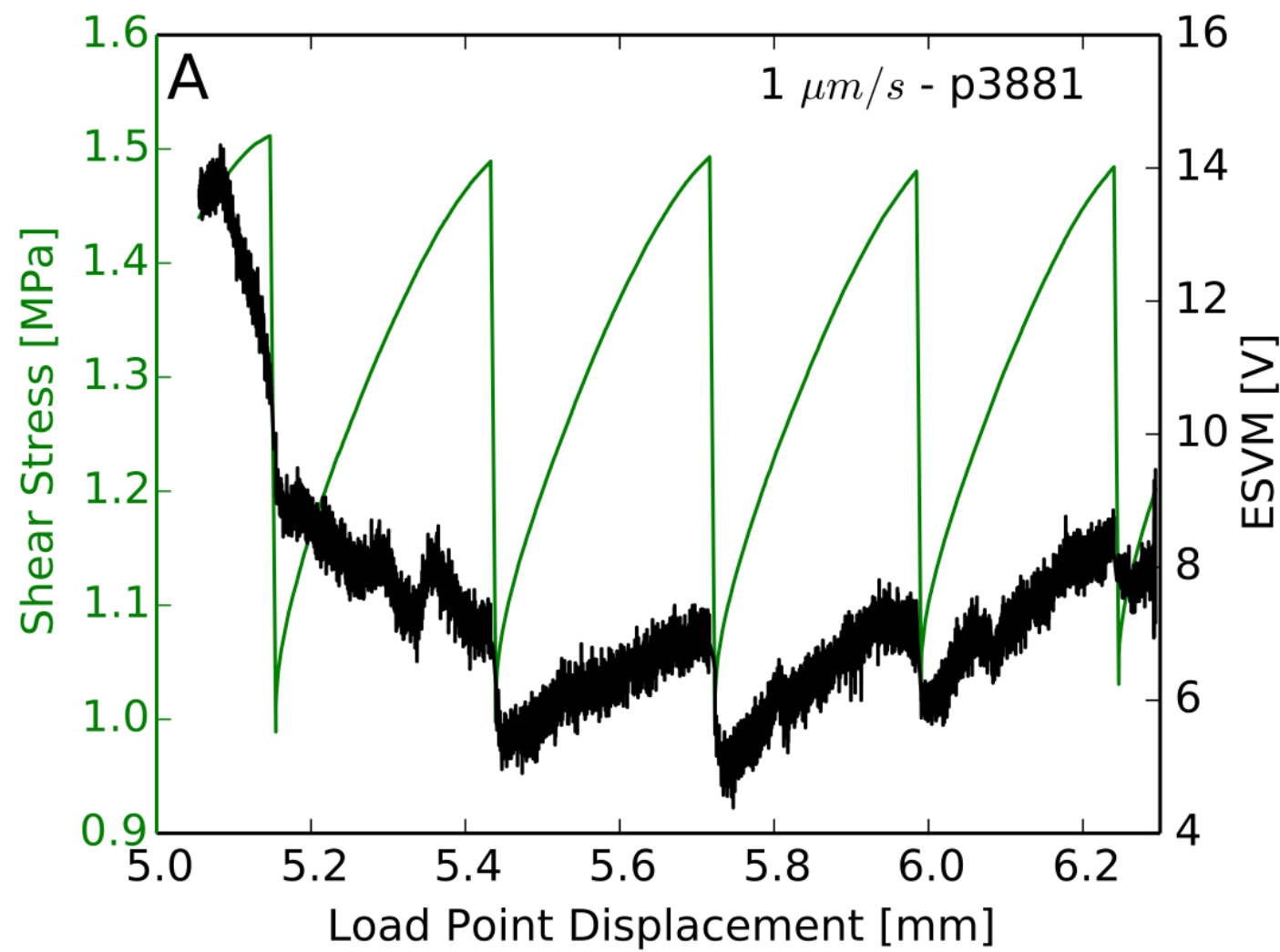
Gouge

ESVM

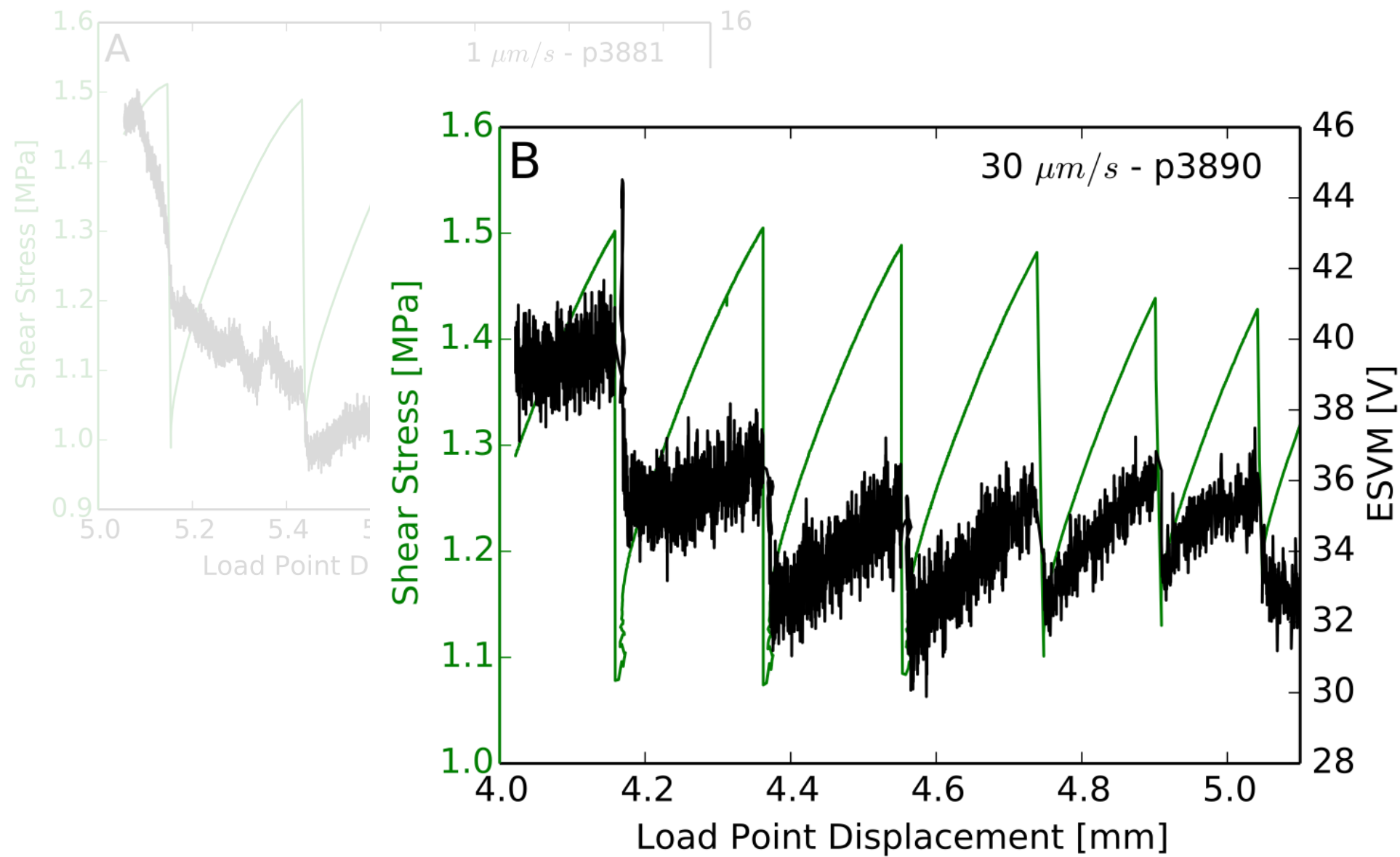
Two electrical signals appear to be convolved and correlated with the mechanical state of the material



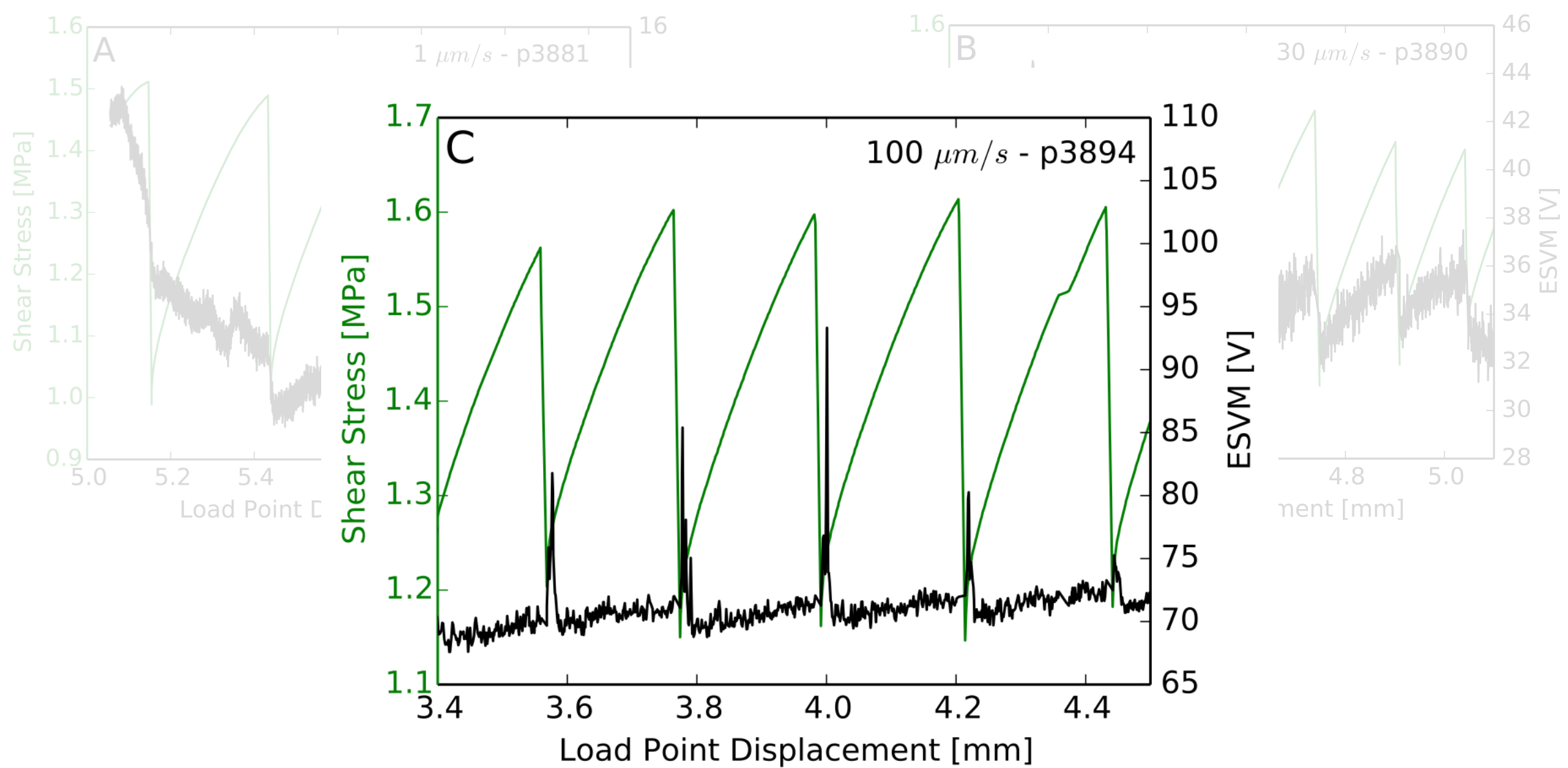
There is a systematic voltage variation with the stress on the glass beads



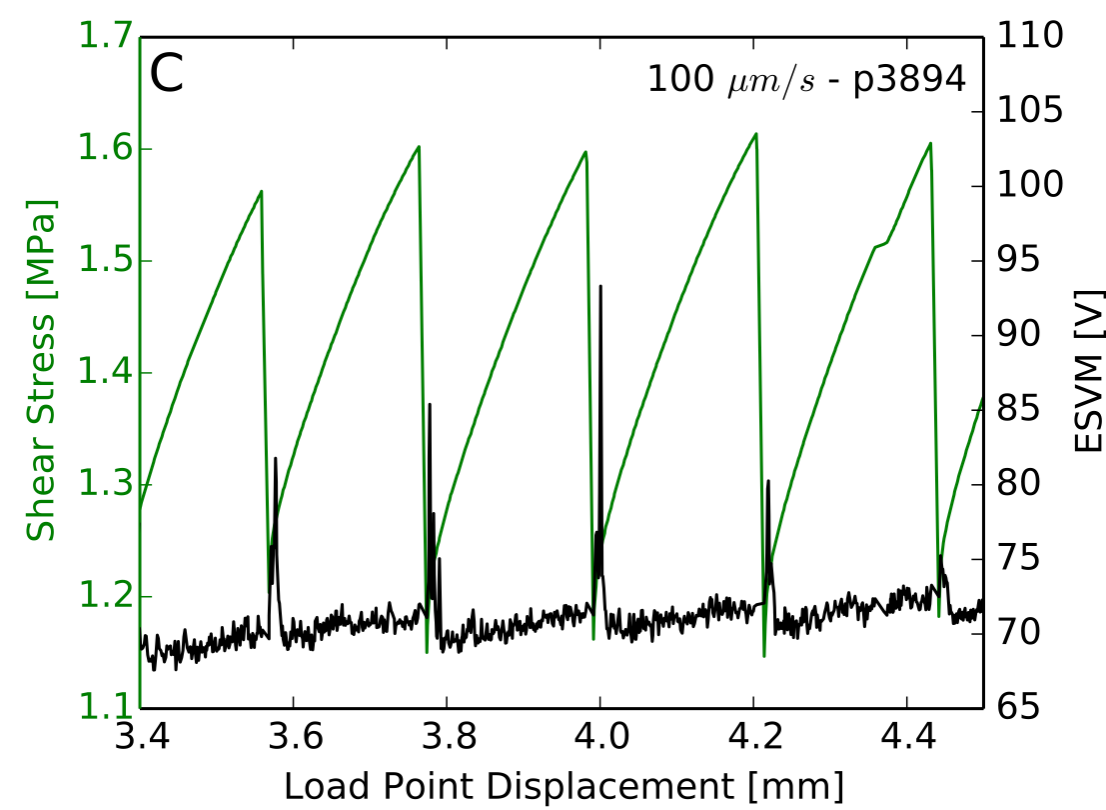
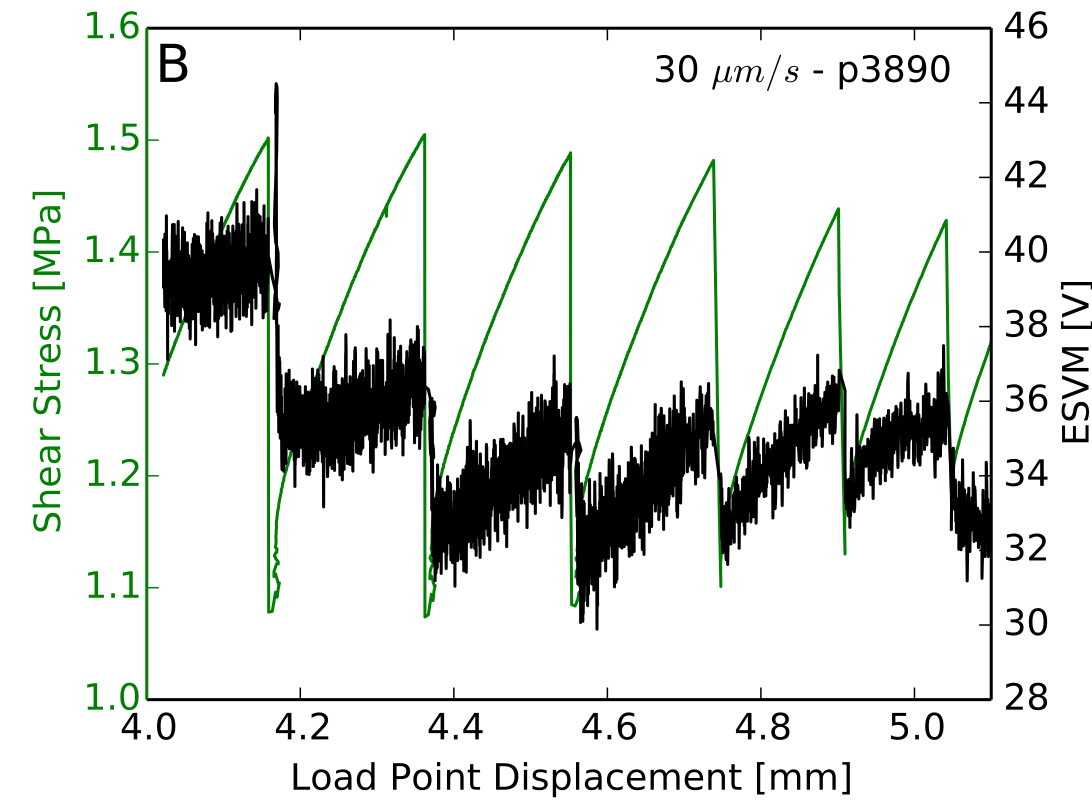
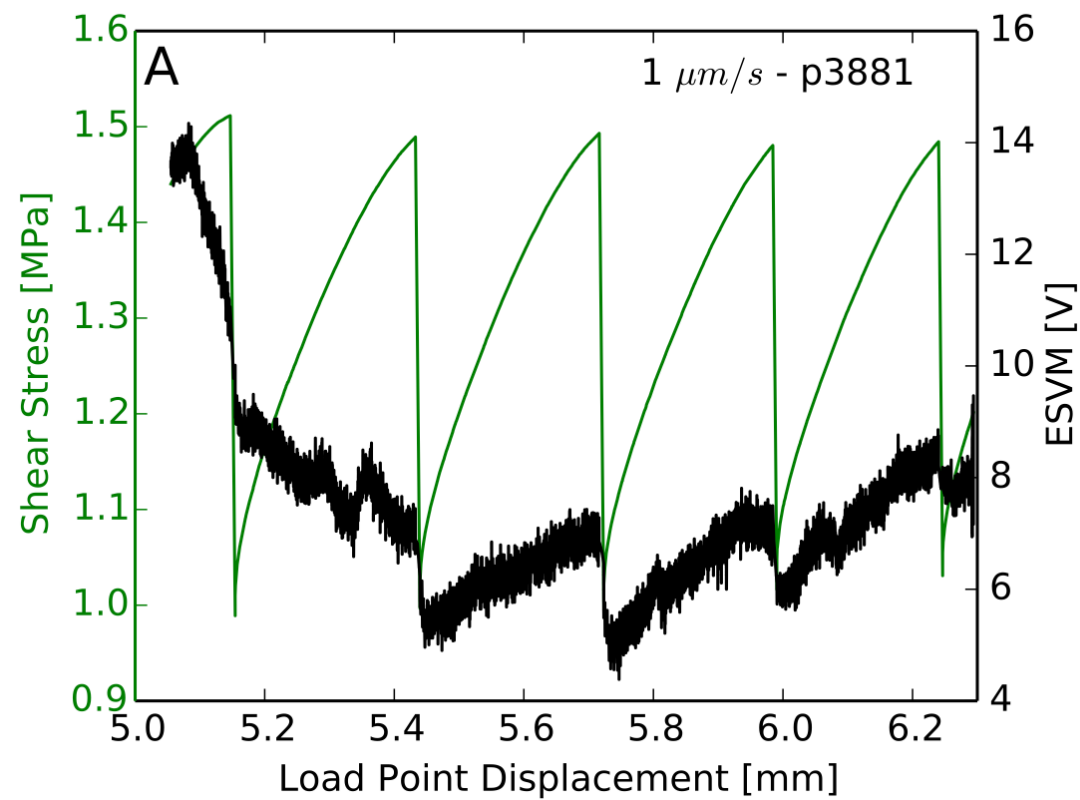
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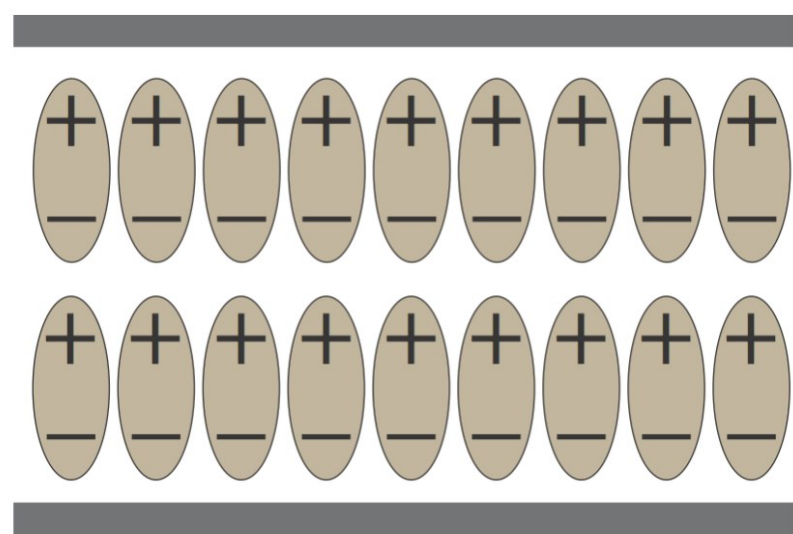
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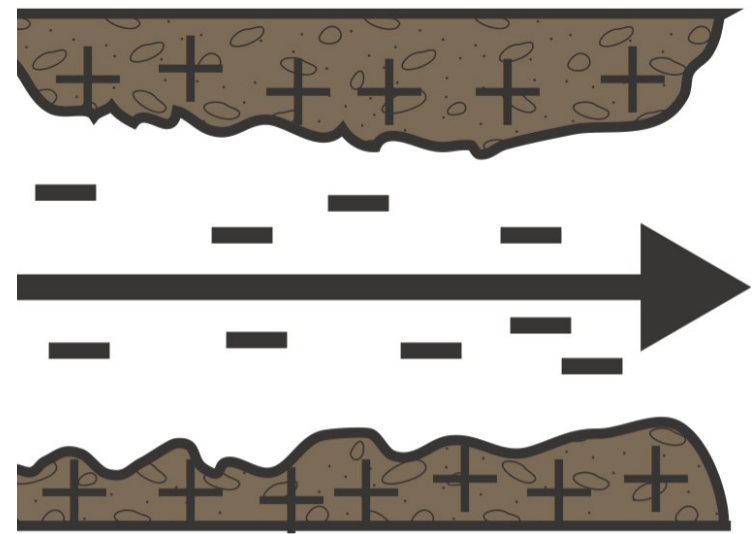
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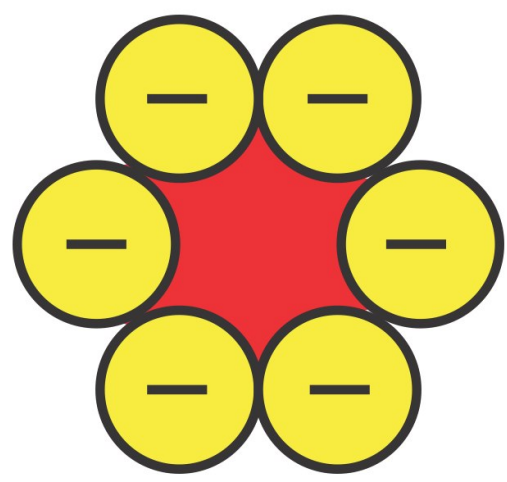
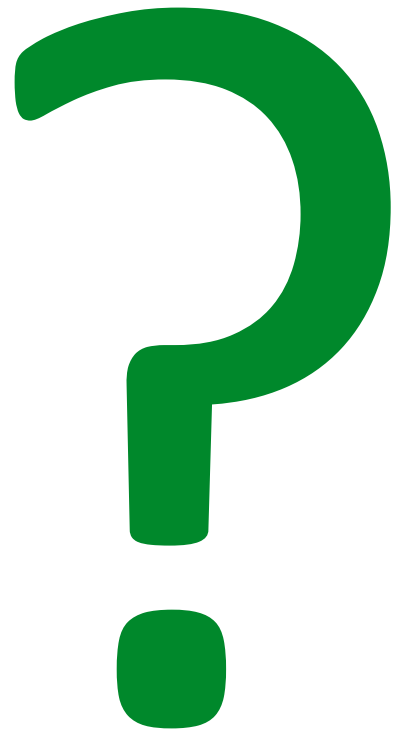
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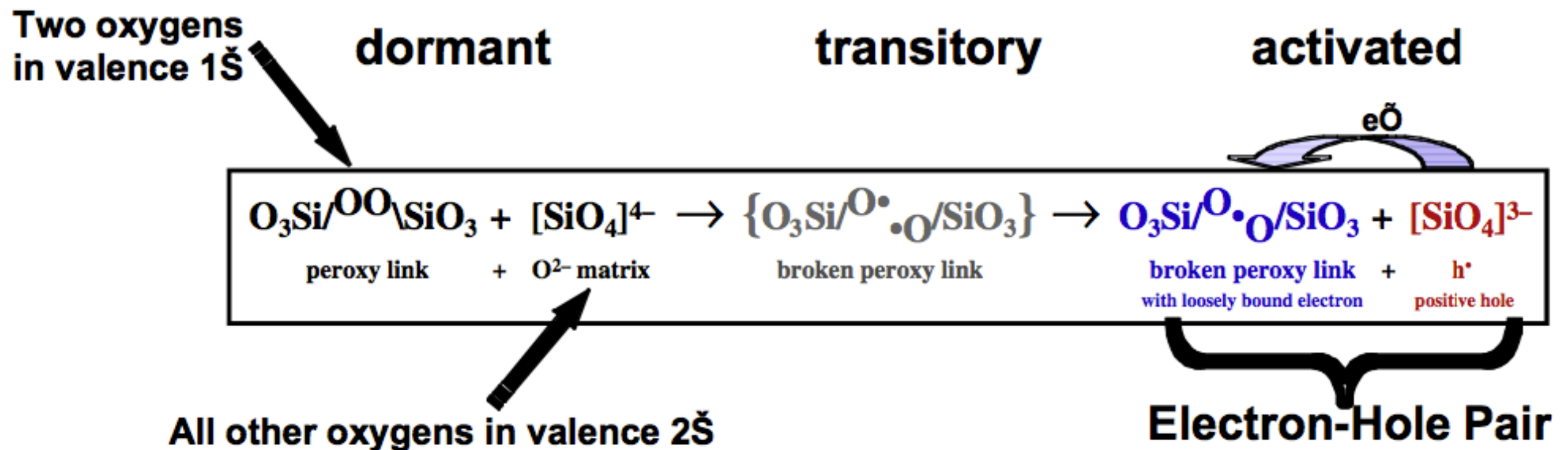


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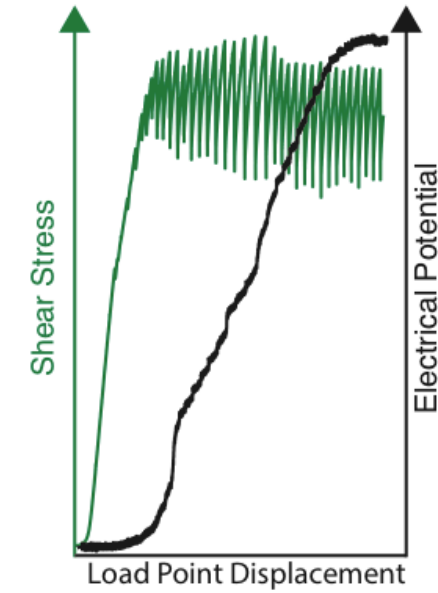
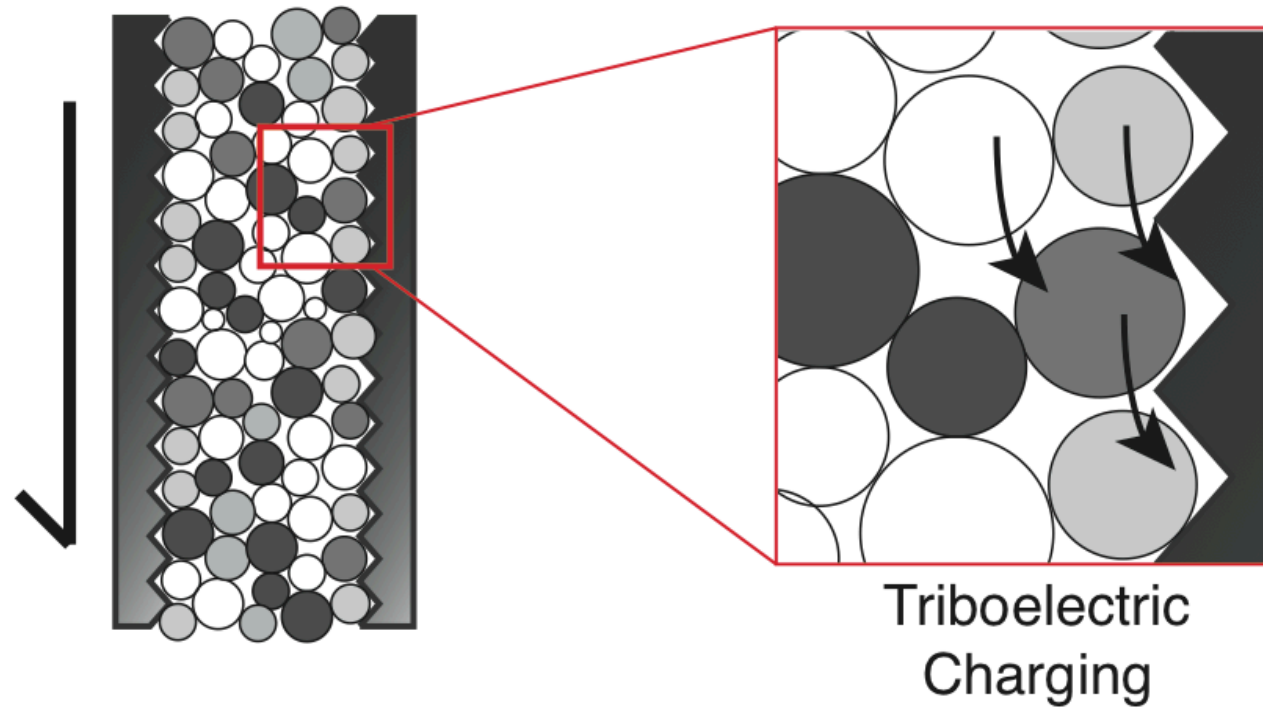


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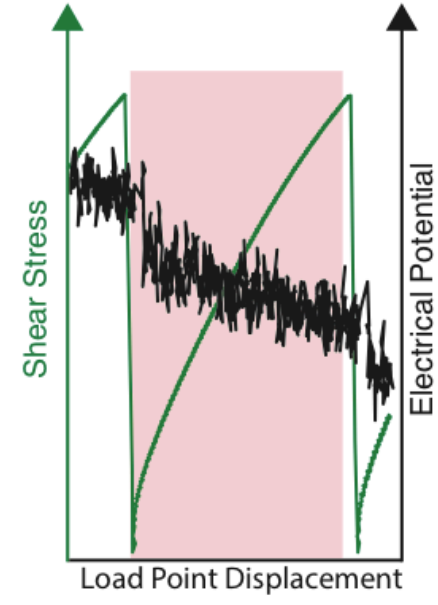
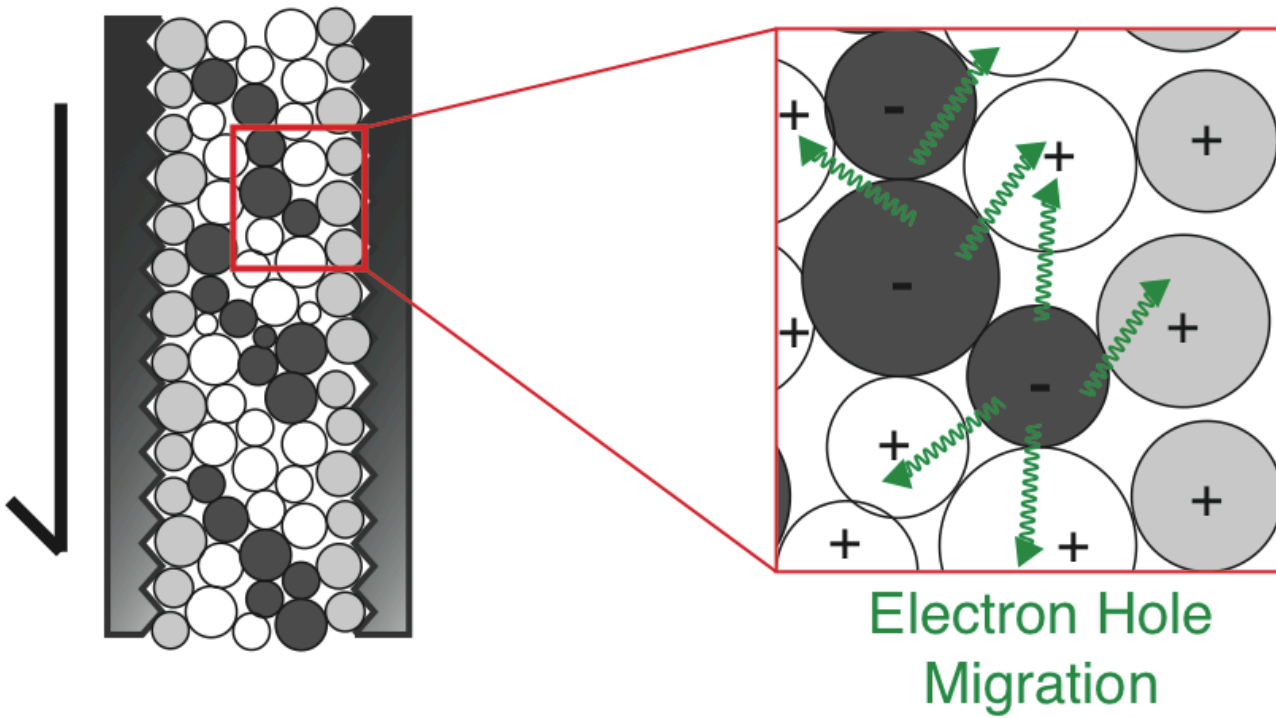
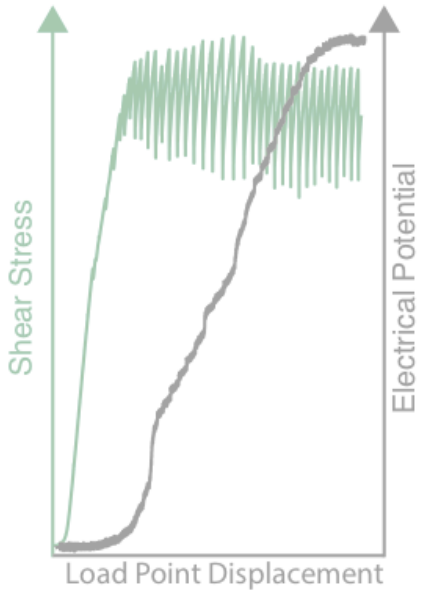
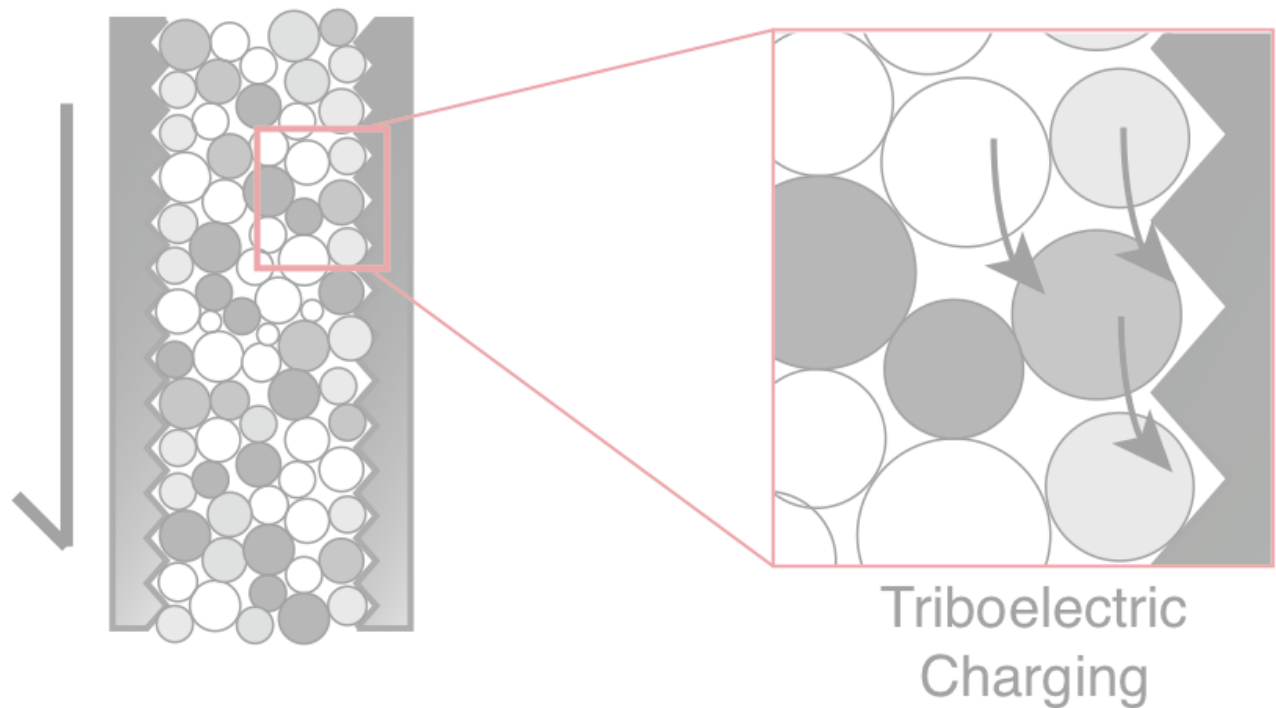
Charge could result from the activation and propagation of positive holes made when peroxy defects are broken



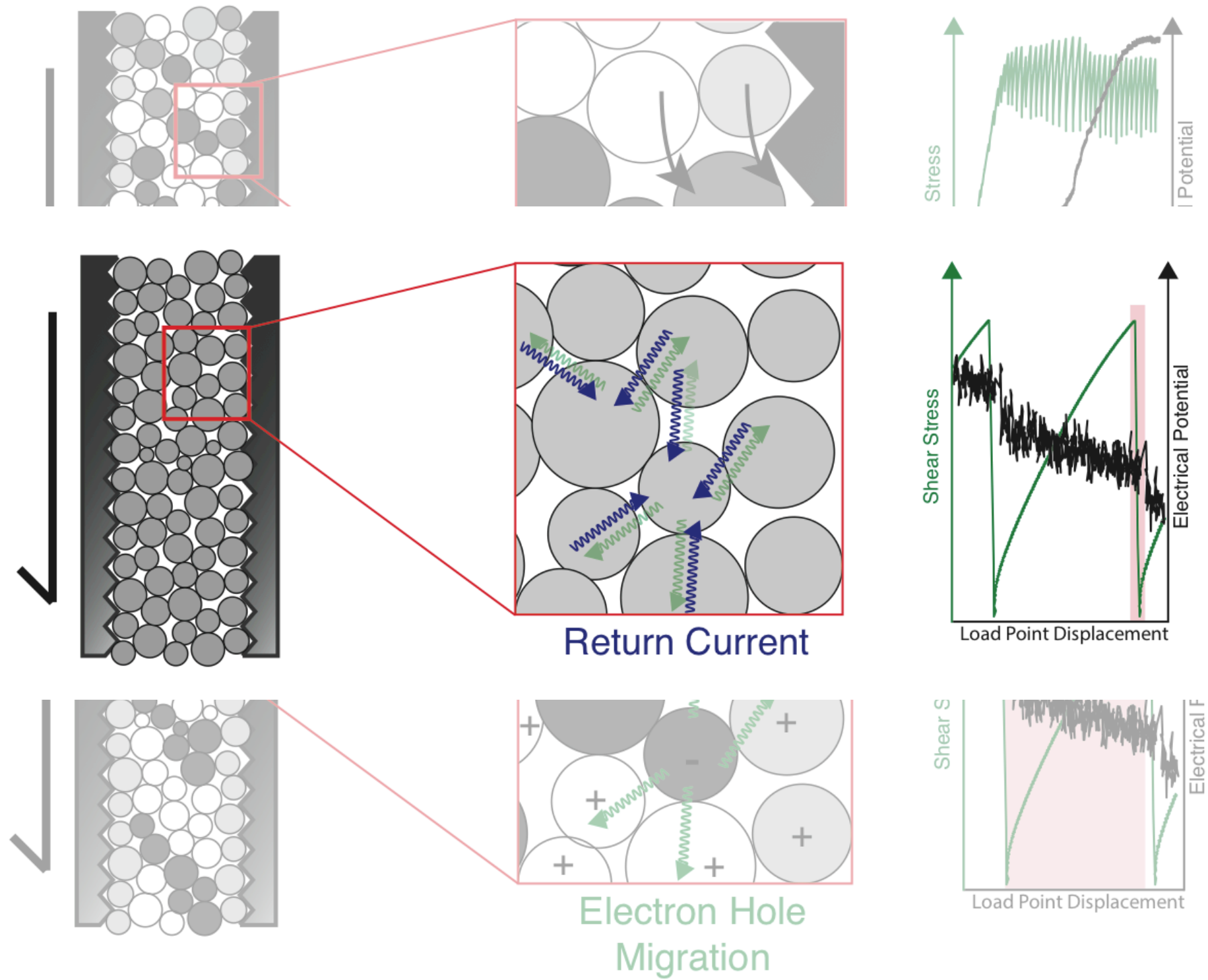
One possible electro-mechanical model connects semiconductor theory with force chain mechanics



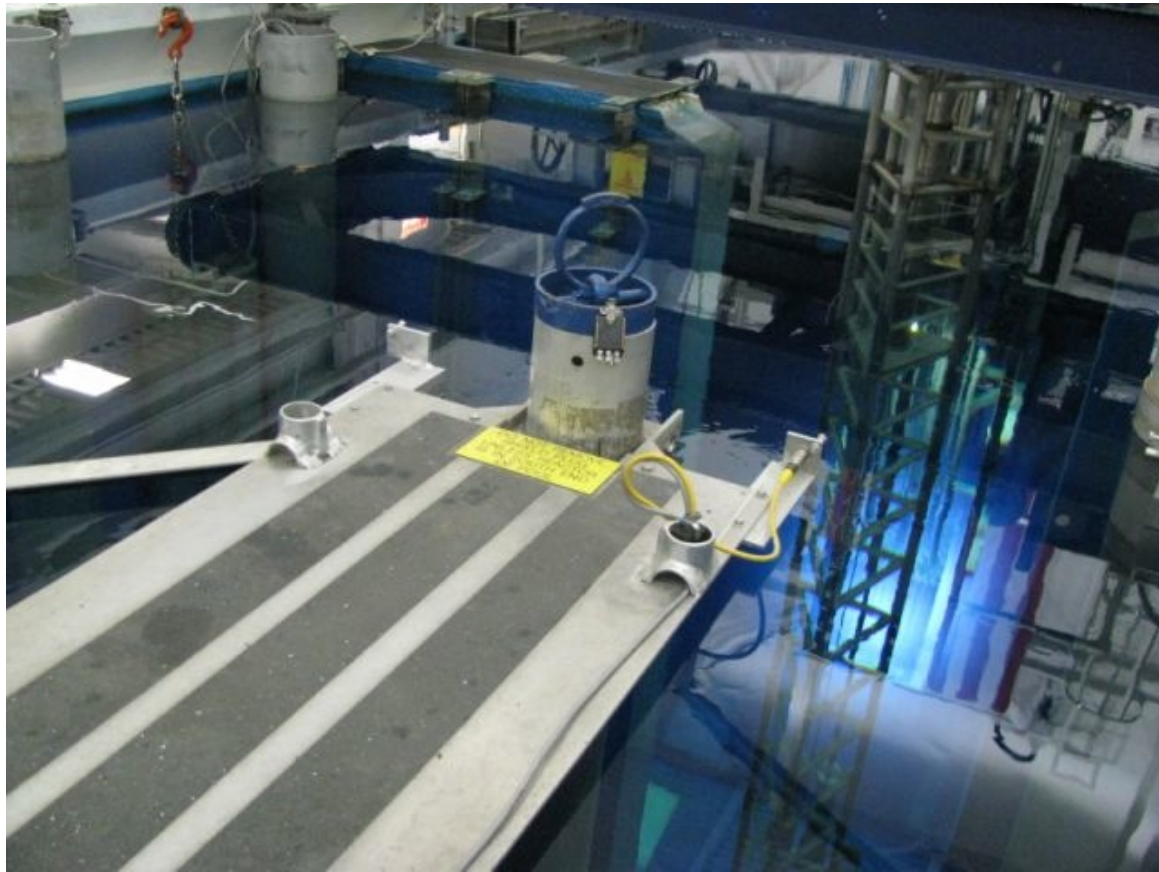
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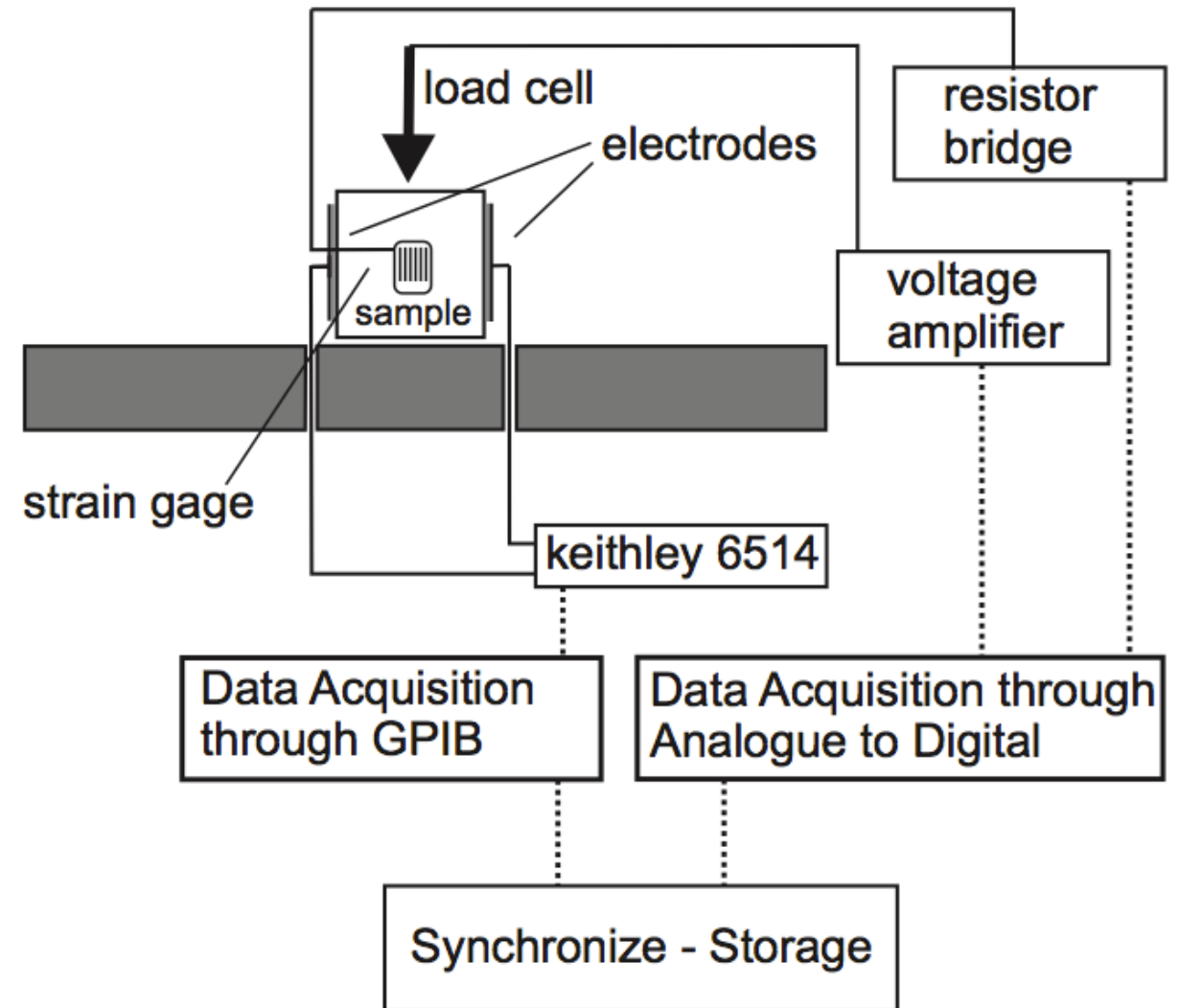


We are further testing these initial results and model by damaging the electronic structure of the material



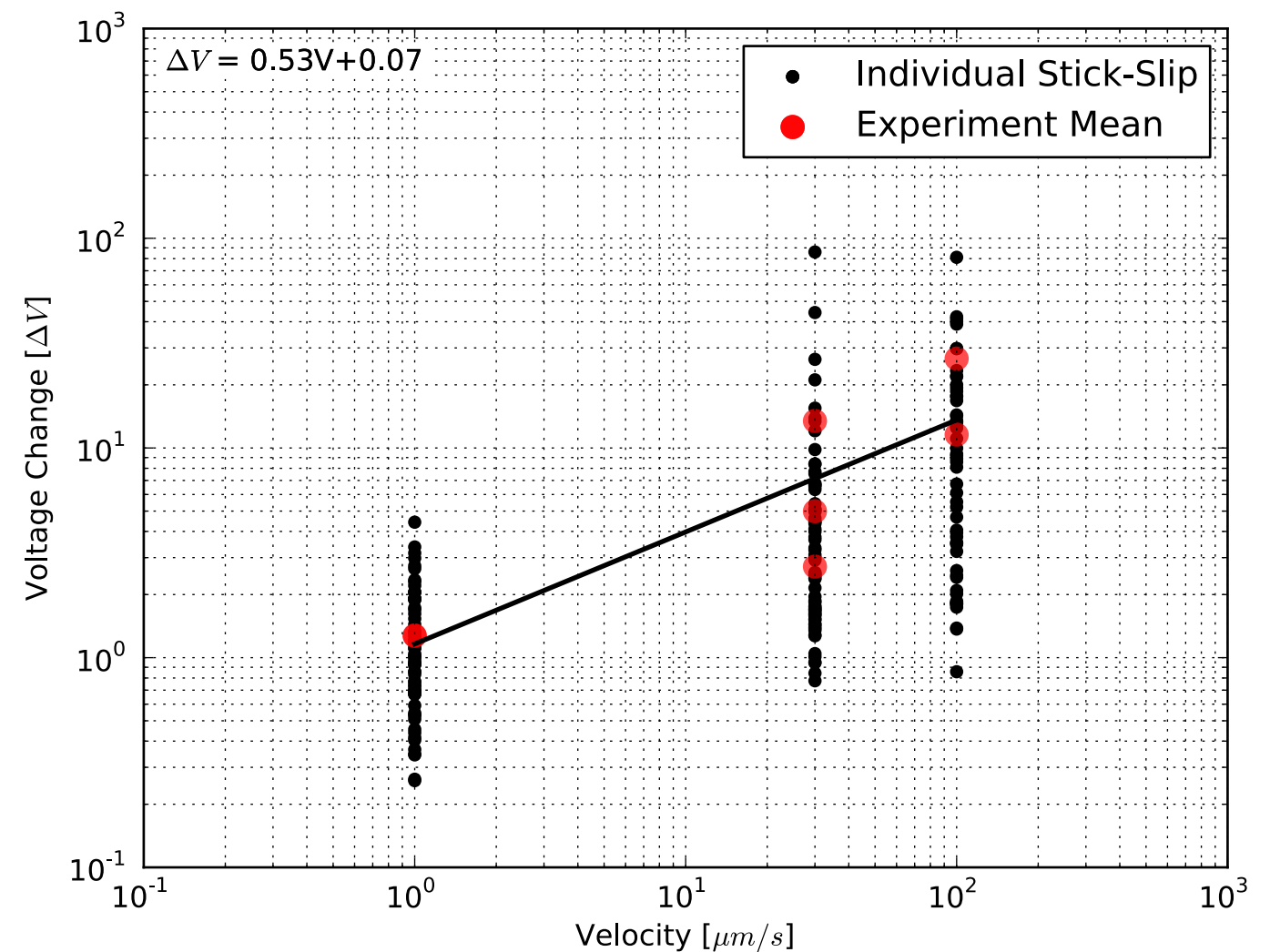
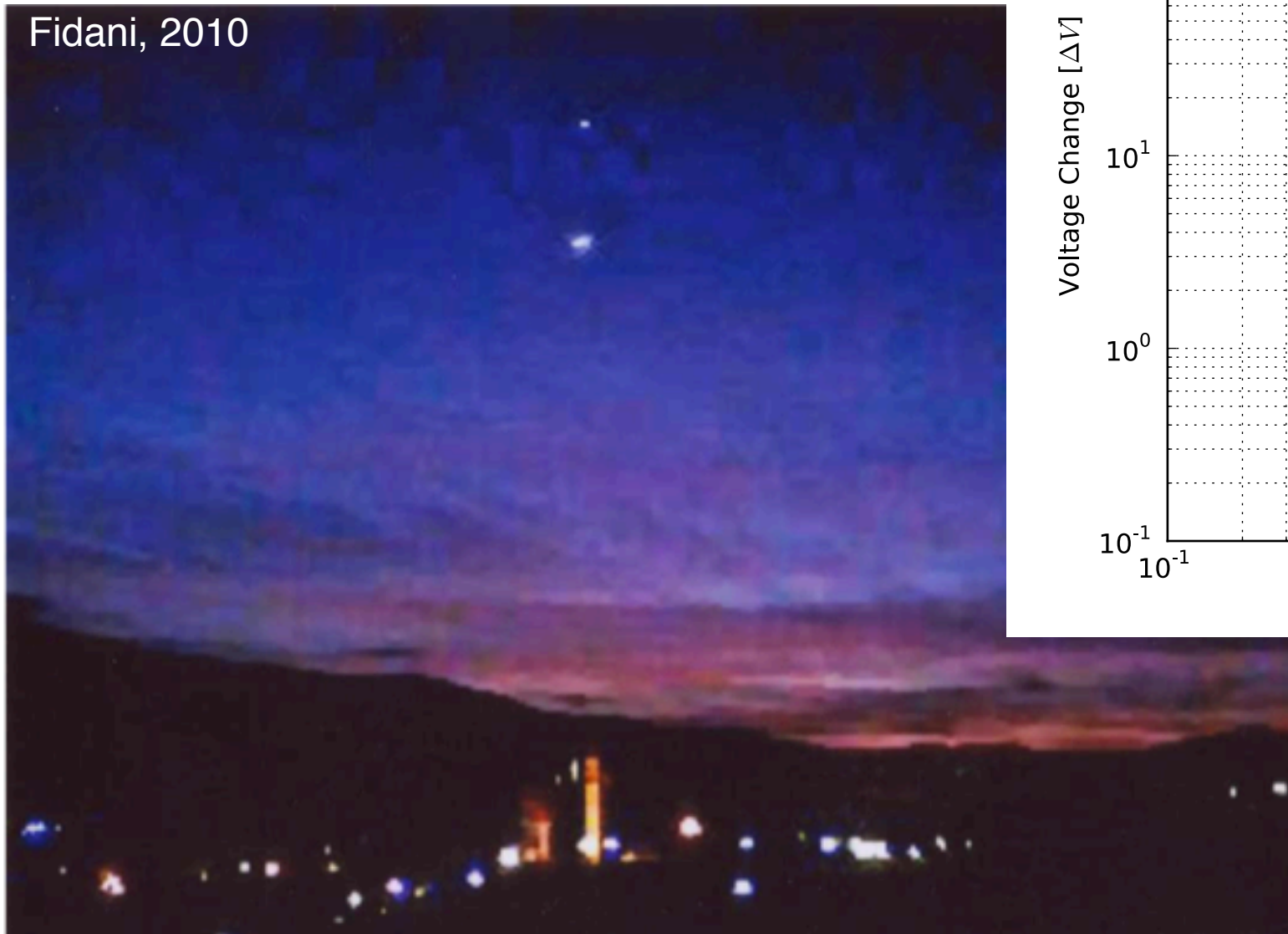
Photos: Dr. Brenden Heidrich

In addition, development of direct contact methods will allow better measurement and more quantitative analysis



Triantis *et al.*, 2008

In summary, we observe a systematic change in electrical potential during stick-slip that may be diagnostic of stress states.



Questions?

OSPA

Outstanding Student Paper Awards

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