Domain boundary engineering in (multi-) ferroics -experiments-

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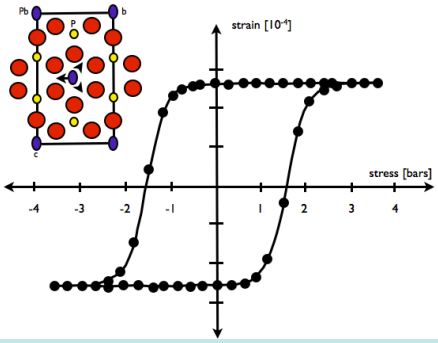
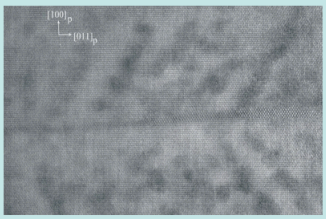
Salje EKH. 2010. Multiferroic domain boundaries as active memory devices: trajectories towards domain boundary engineering. *ChemPhysChem* 11:940--50

Salje EKH 1993 Phase Transitions in ferroeleastic and co-elastic crystals Cambridge University Press , Cambridge UK

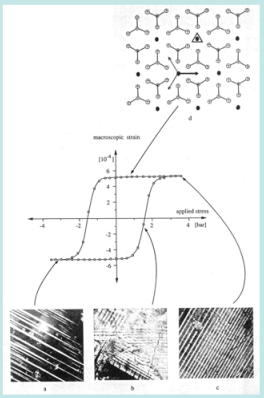
Van Aert S, Turner S, Delvill R, Schreyvers D, Van Tendeloo G, Salje EKH 2012
Direct observation of ferrielectric domain boundaries in CaTiO3 by electon microscopy
Advanced Materials 34: 523-527

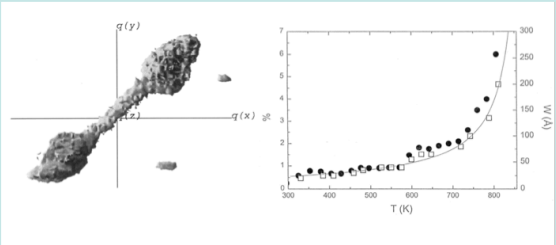




Typical wall thickness in perovskites at $T<<T_c$ is >2nm

twin walls can be generated easily and twin walls can be moved by external stresses This allows the formation of specific patterns according to applications





diffraction to measure the thickness of interfaces

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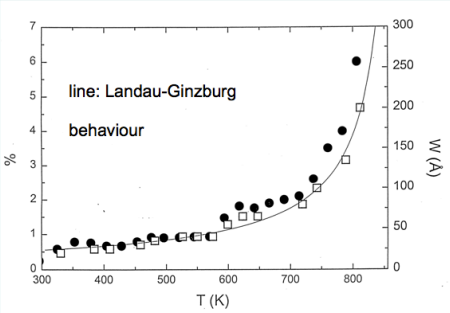
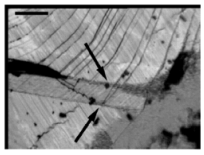
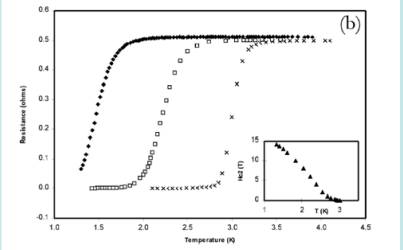


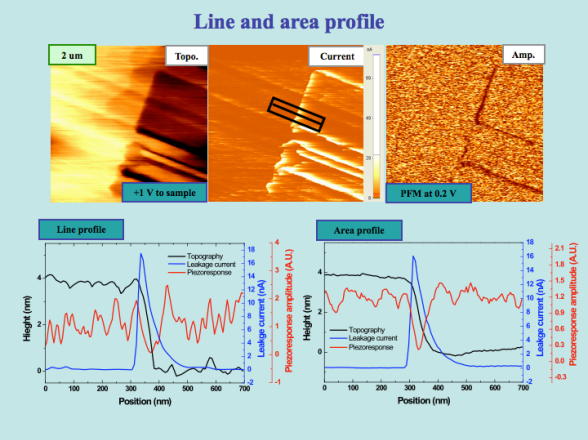
Temperature evolution of the wall thickness in $LaAlO_3$

(Chrosch & Salje, JAP 1999)

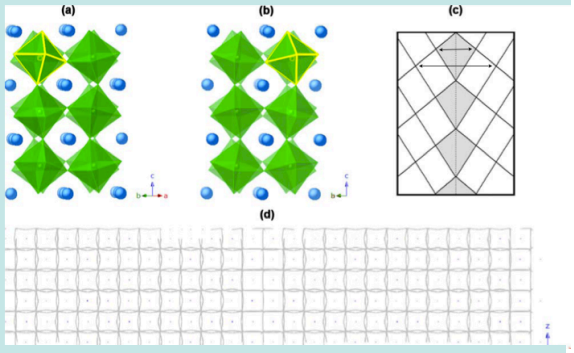


Supercurrents along twin boundaries In WO_3

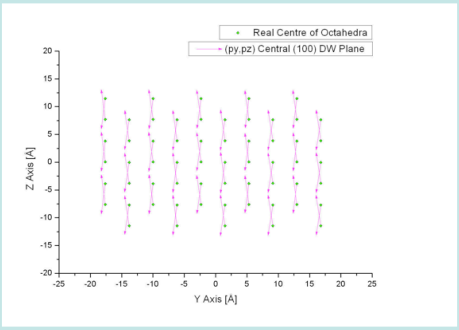


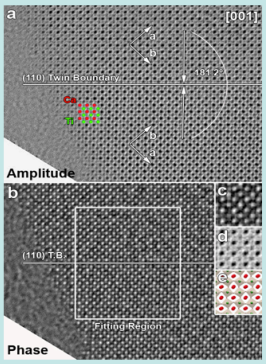


ferrielectric twin walls in $CaTiO_3$



CaTiO3 ferroelectric and anti-ferroelectric distortion in ferroelastic twin walls





$CaTiO_3$

Titan TEM reconstructions for amplitude and phase (2012) in press

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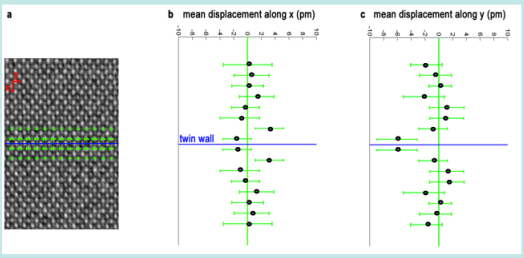

Ti atoms are shifted to the left, amplitude ca. 6pm
no shifts for Ca beyond the thermal noise level

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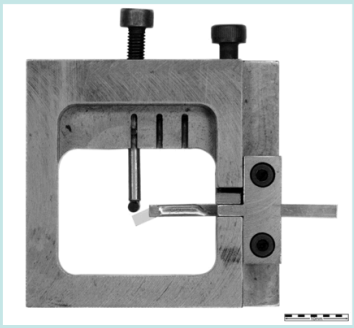
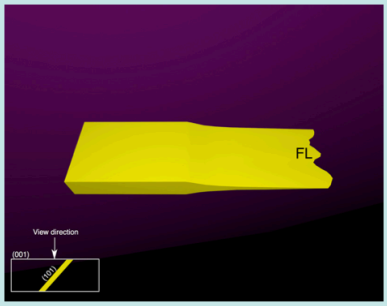
quasi-static shear experiment





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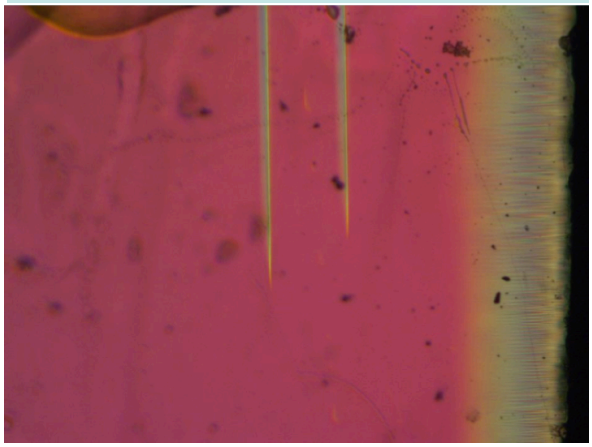

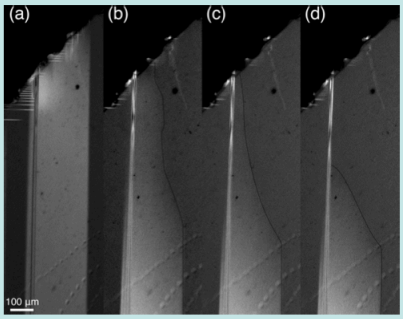

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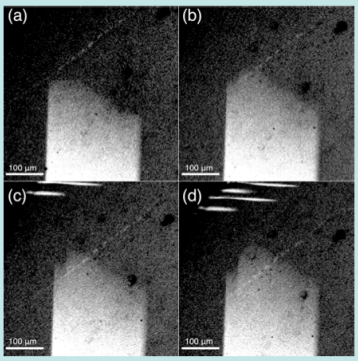

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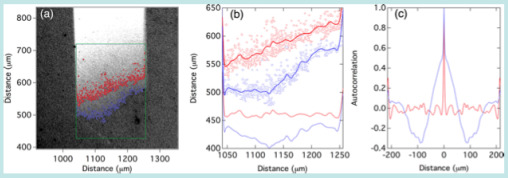

the front line defines the Larkin length while the Larkin length of the surface planes remains infinite

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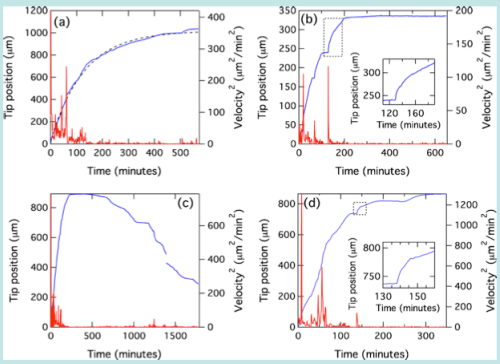
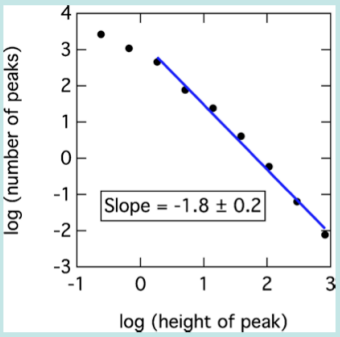
Jerky propagation and energy spectrum





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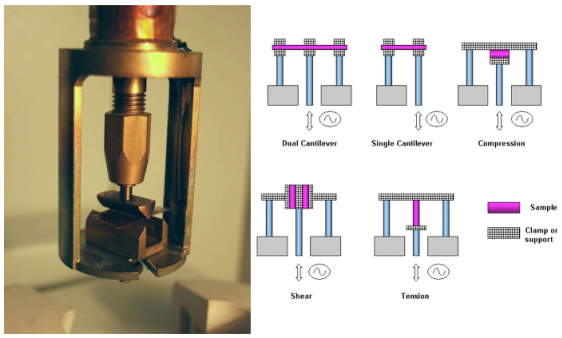
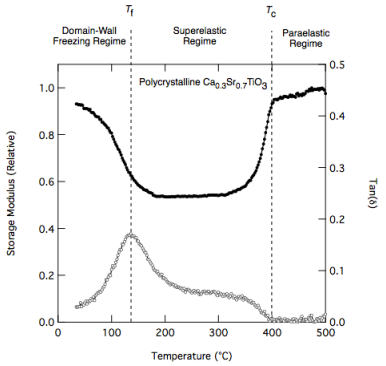


dynamical mechanical analyzer (0.01 - 30 Hz)

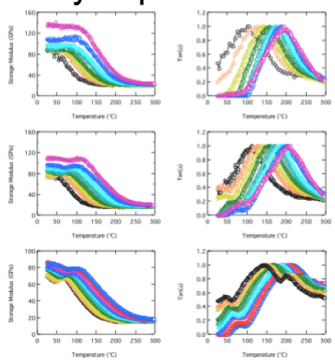


Frequency-dependence

90:100 mN

200:220 mN

450:500 mN



Elastic response function

- $J(t)=\varepsilon(t)/\sigma=J_{unrelaxed} + \Delta J(1-\exp(-t/\tau))$

$J(\omega)= J_{unrelaxed} + \Delta J\ (1/(1+i\omega\tau))$ Debye

- Extended Debye

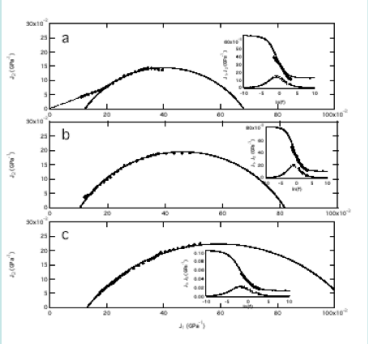
$J(\omega)= J_{unrelaxed} + \Delta J\ (1/(1+i\omega\tau)^{\mu})$

- Equivalent to density function in τ

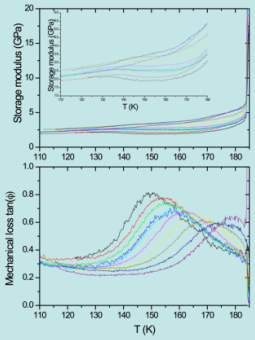
$\rho(\tau)=(\tau^{\mu-1}\sin(\mu\pi)/\pi)/(1+\tau^{2\mu}+2\tau^{\mu}\cos(\pi\mu))$

- First moment $\tau\rho(\tau)$ gives the probability function of τ

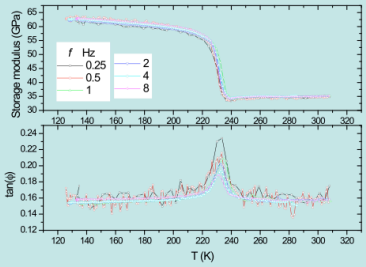
Elastic Cole-Cole plots: 'flattened' semicircles



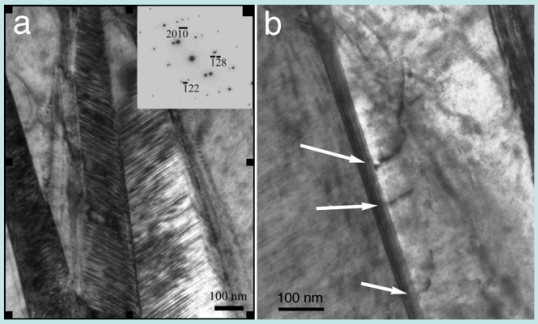
'standard' elastic softening by mobile walls in $KMnF_3$



Mobile interface austenite/martensite but no mobility martensite/martensite

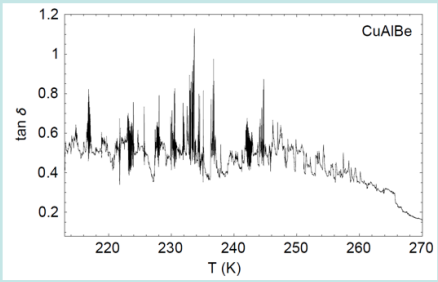


Dislocations nucleating in a twin wall in CuAlBe

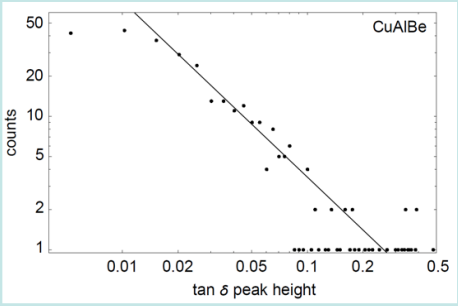


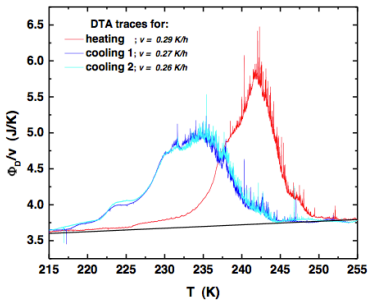
Avalanches in martensites

(Salje et al. APL 2009)

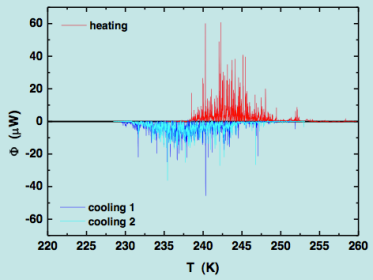


Power law for avalanches (τ =1.3)





CuAlZn



jerk contribution

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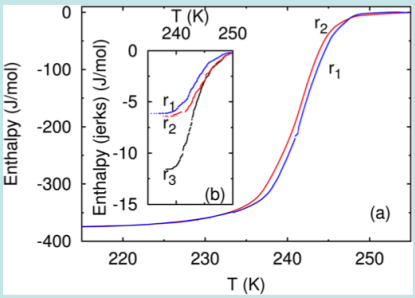

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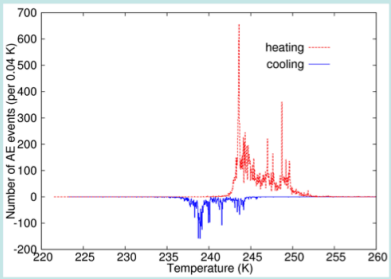

acoustic emission

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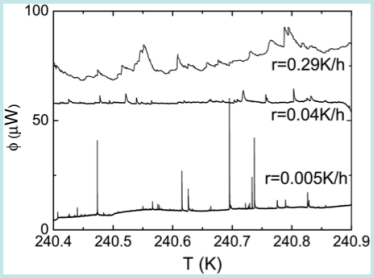

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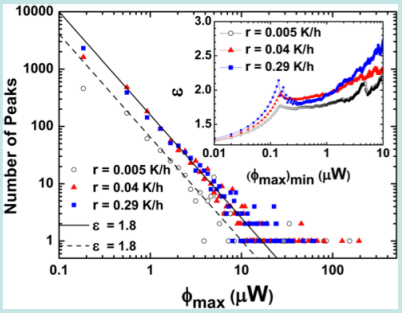

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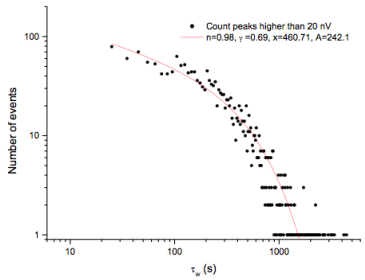

Statistical distribution of the waiting time between jerks.
The quantitative parameterization of the distribution
$p(wt) \sim wt^{(\gamma-1)}\exp(-wt/\tau)^n$
leads to $n=1$, $\gamma=0.7$, and $\tau=460$ s.

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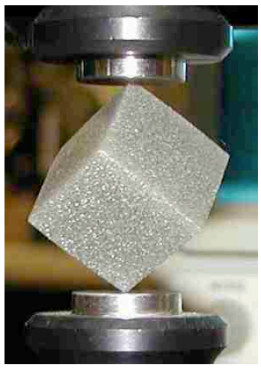
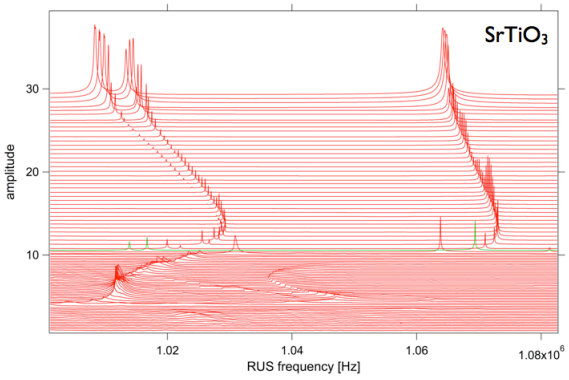
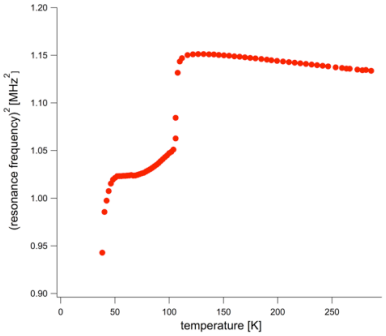
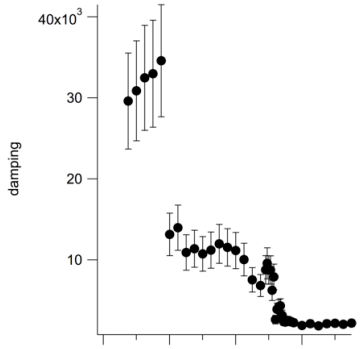
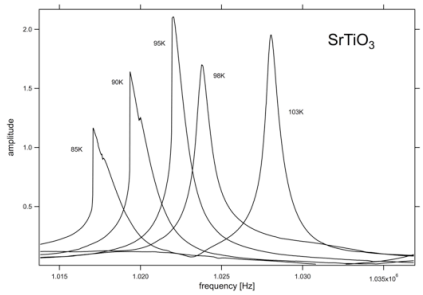


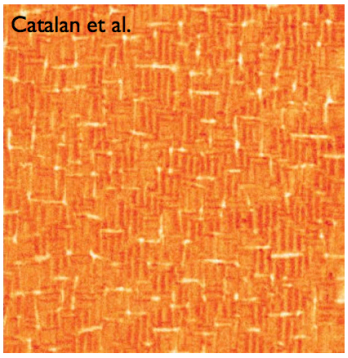
fast (kHz-MHz)
resonance ultrasonic
spectroscopy
RUS

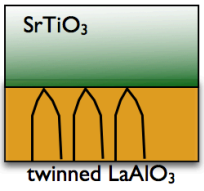




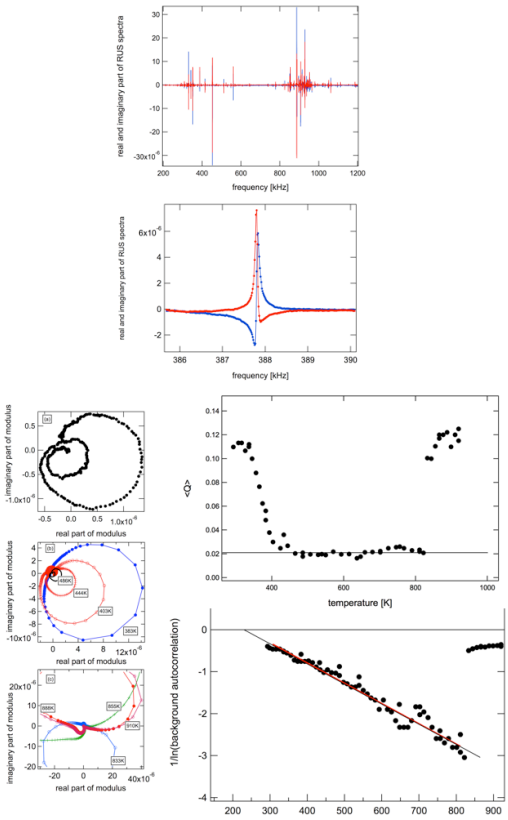


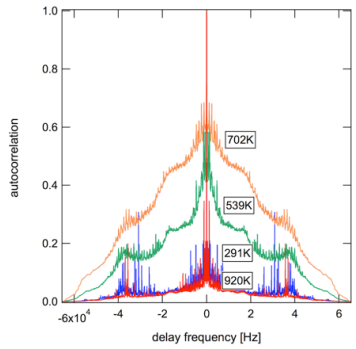






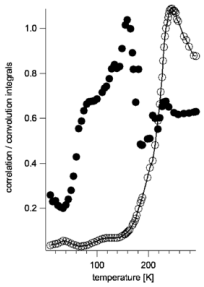
twinning in flexomechanics: here an interface between $LaAlO_3$ on $SrTiO_3$





autocorrelation function LaAlO3

magnetic transitions



Temperature evolution of the integral autocorrelation, ψ, (black circles) and the integrated convolution, λ (open circles)