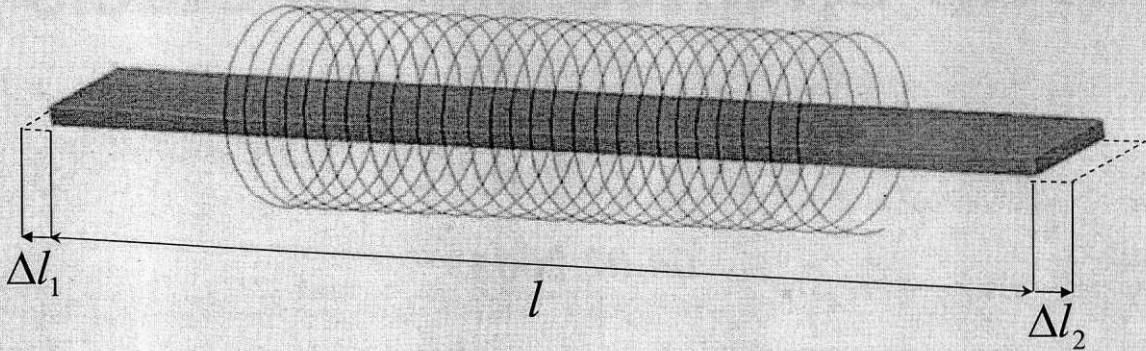
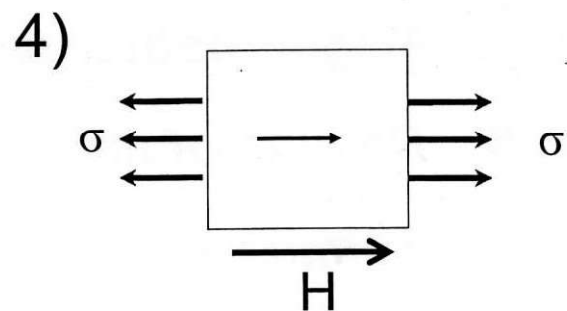
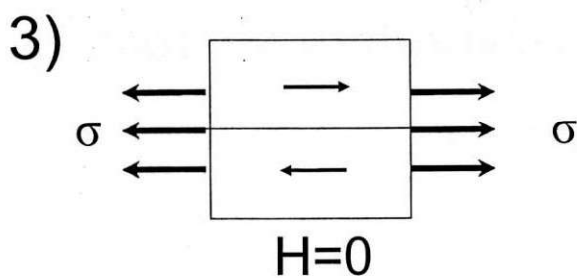
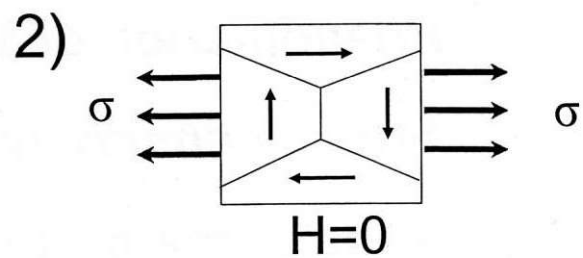
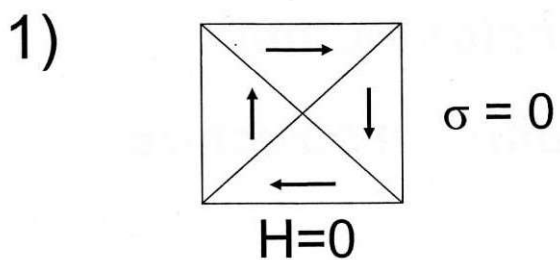


# Magnetostriction

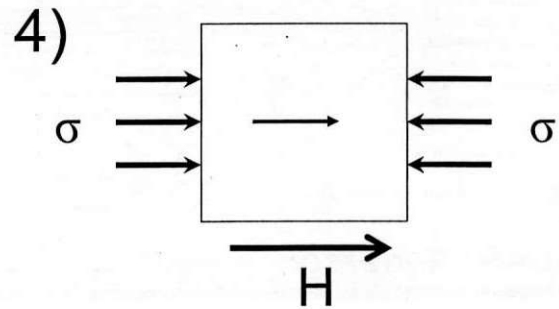
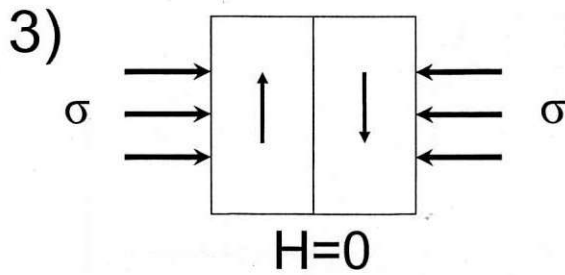
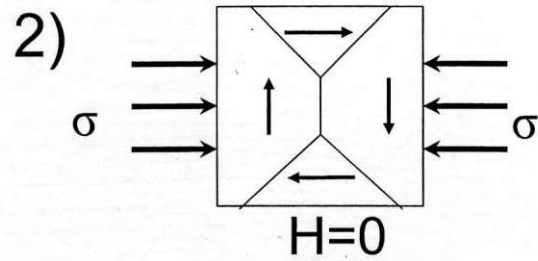
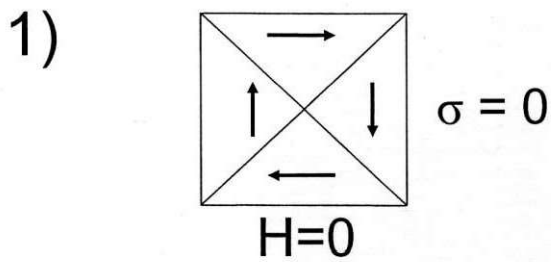
$$\lambda = \frac{\Delta l}{l}$$



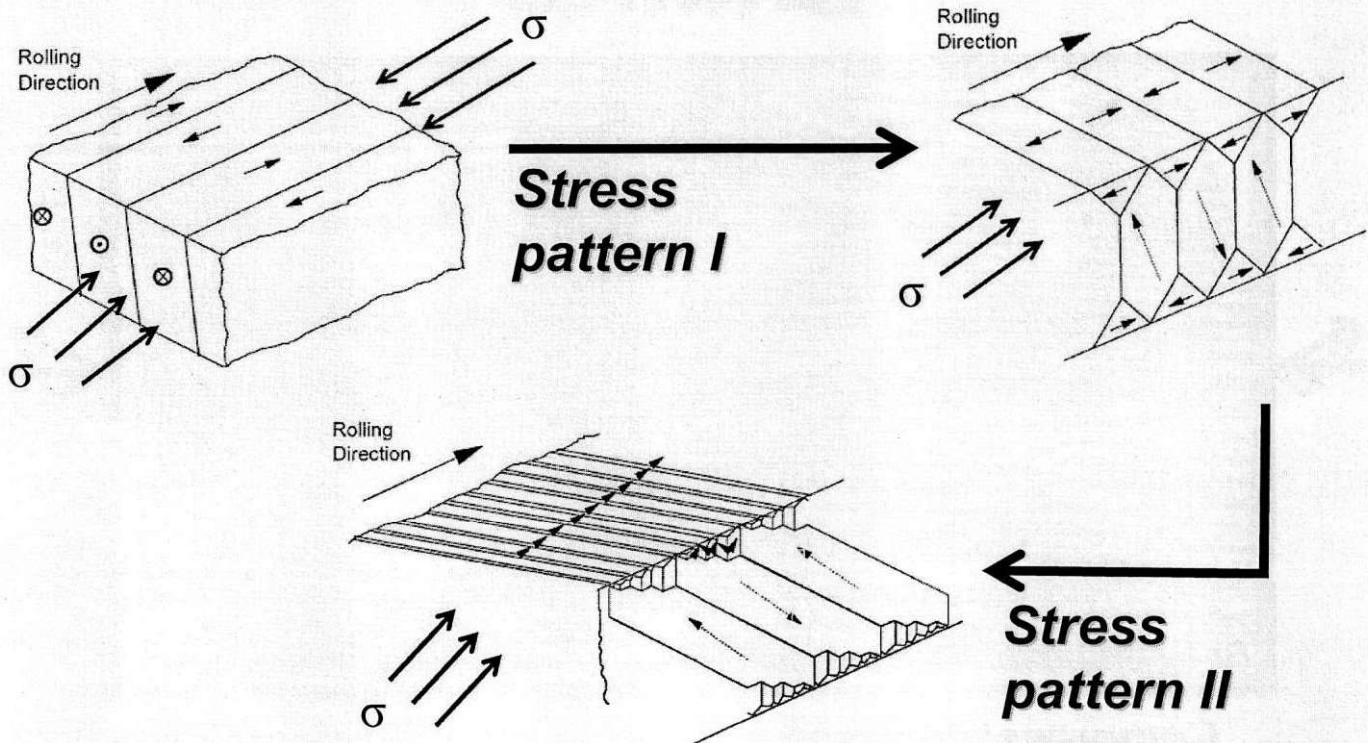
## Magnetisation of a material with positive magnetostriction under tensile stress



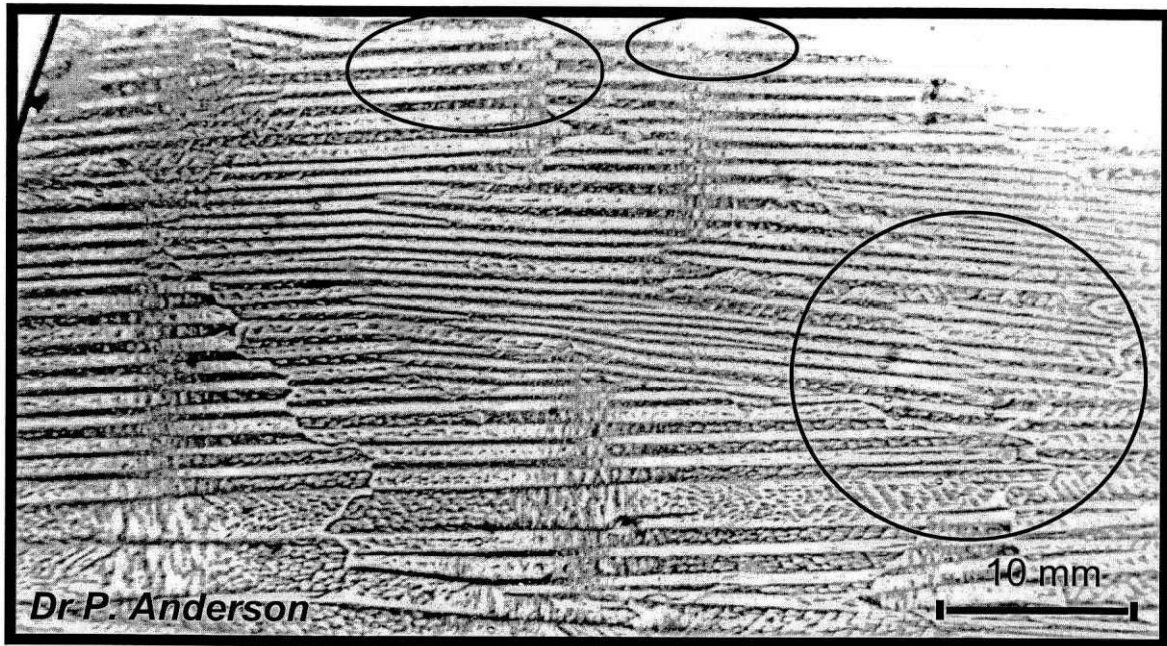
## ***Magnetisation of a material with positive magnetostriction under compressive stress***



## ***Domains due to Compressive Stress***

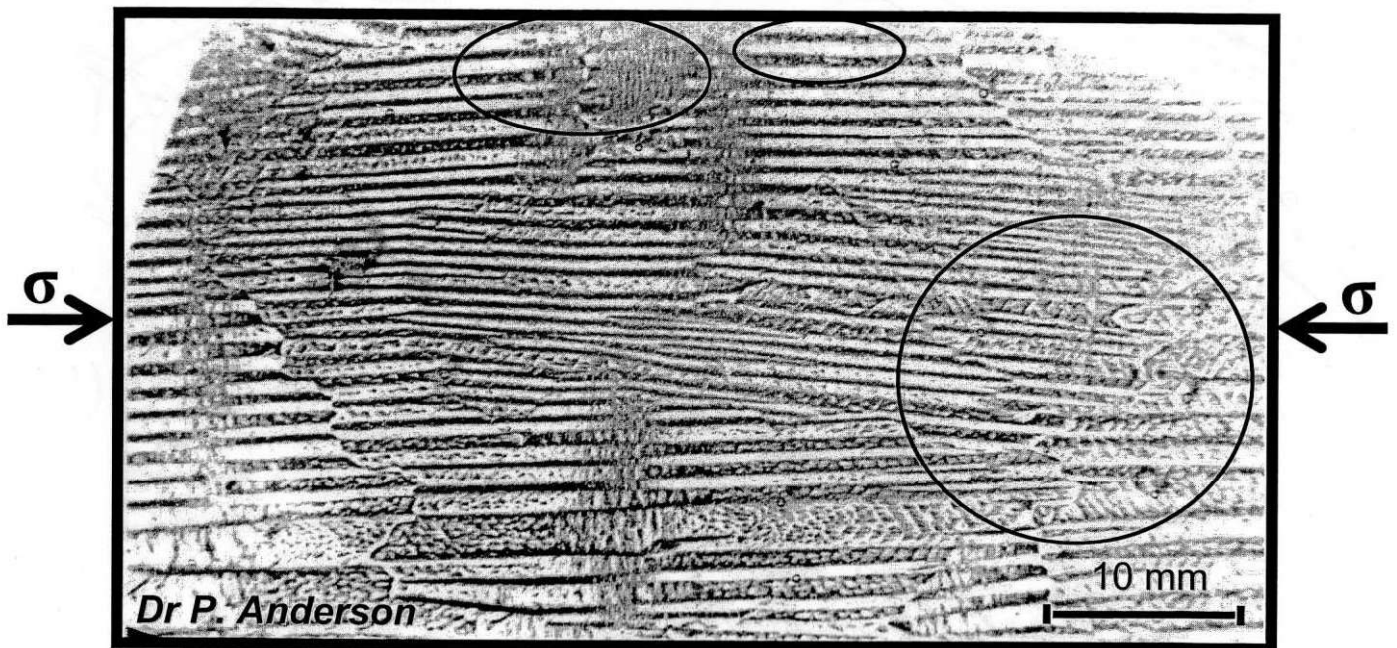


**0 MPa**



**No stress applied in a rolling direction**

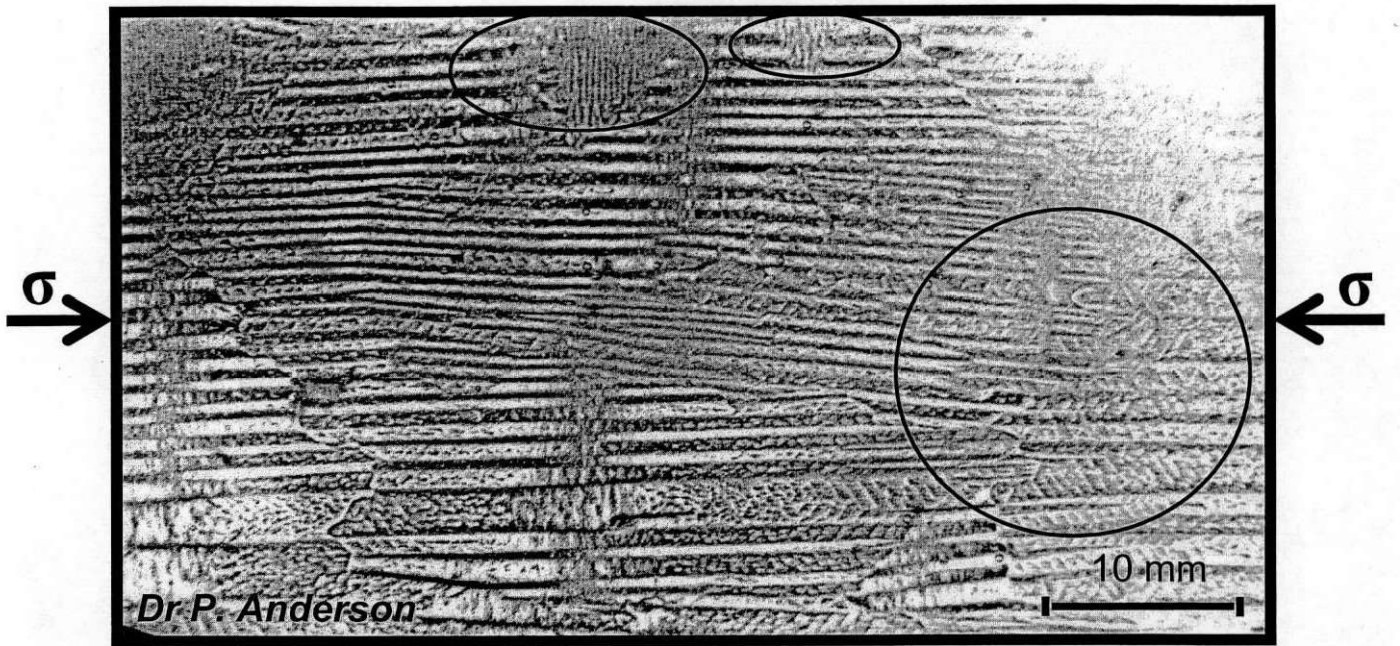
**-2 MPa**



**Compressive stress applied in a rolling direction**

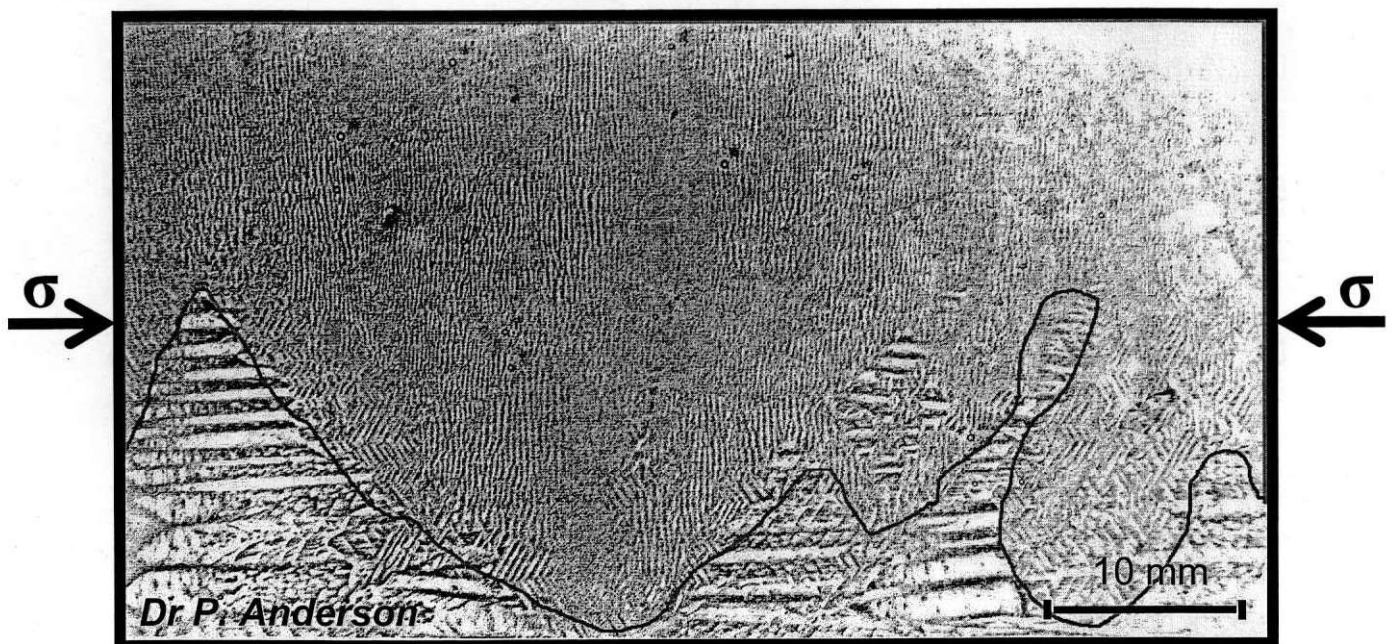


***-4 MPa***



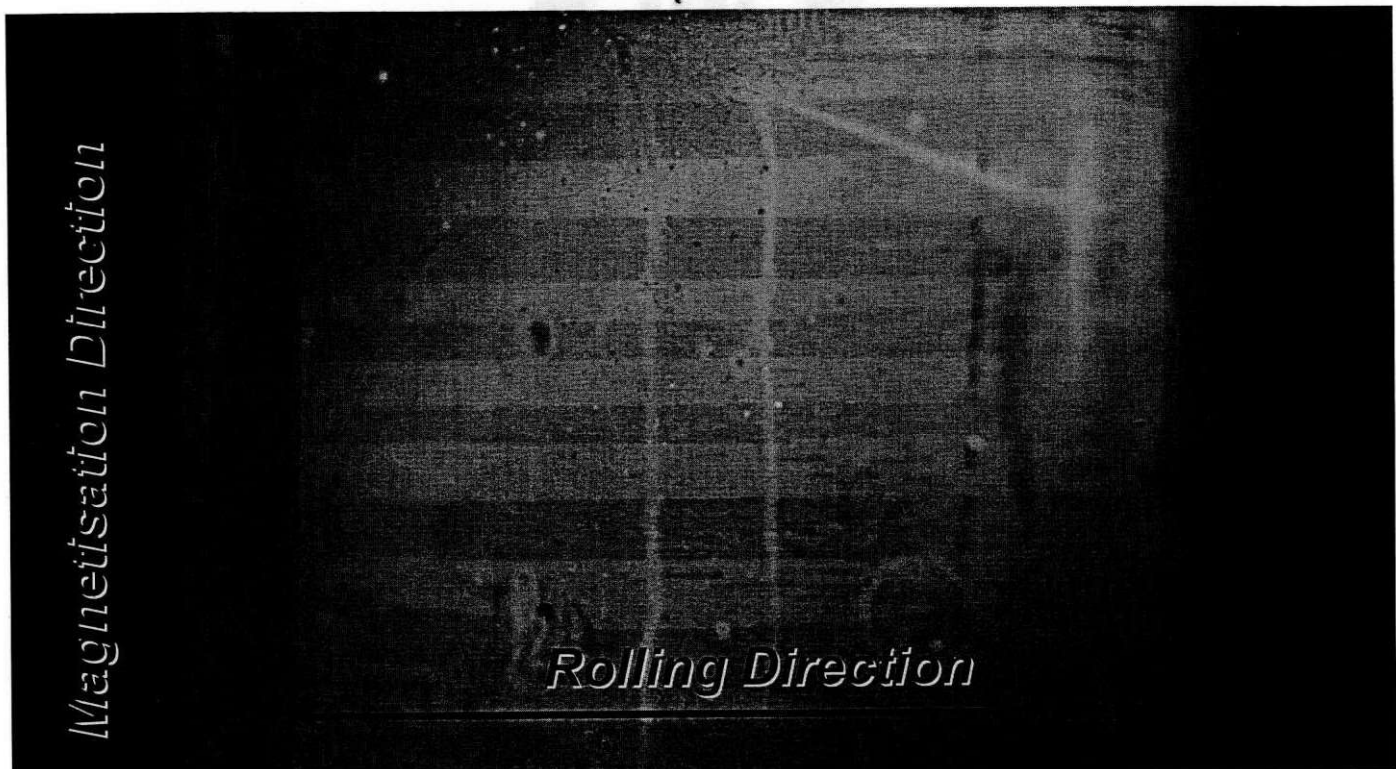
***Compressive stress applied in a rolling direction***

***-5 MPa***



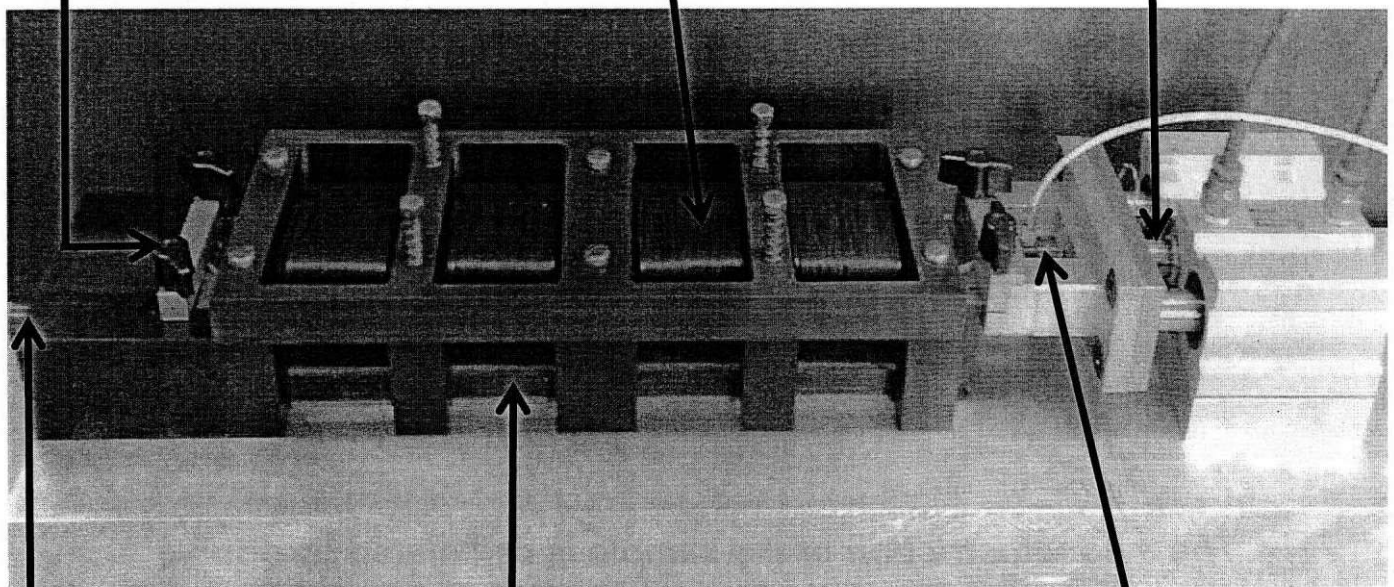
***Compressive stress applied in a rolling direction***

## ***Sample magnetised in transverse direction***

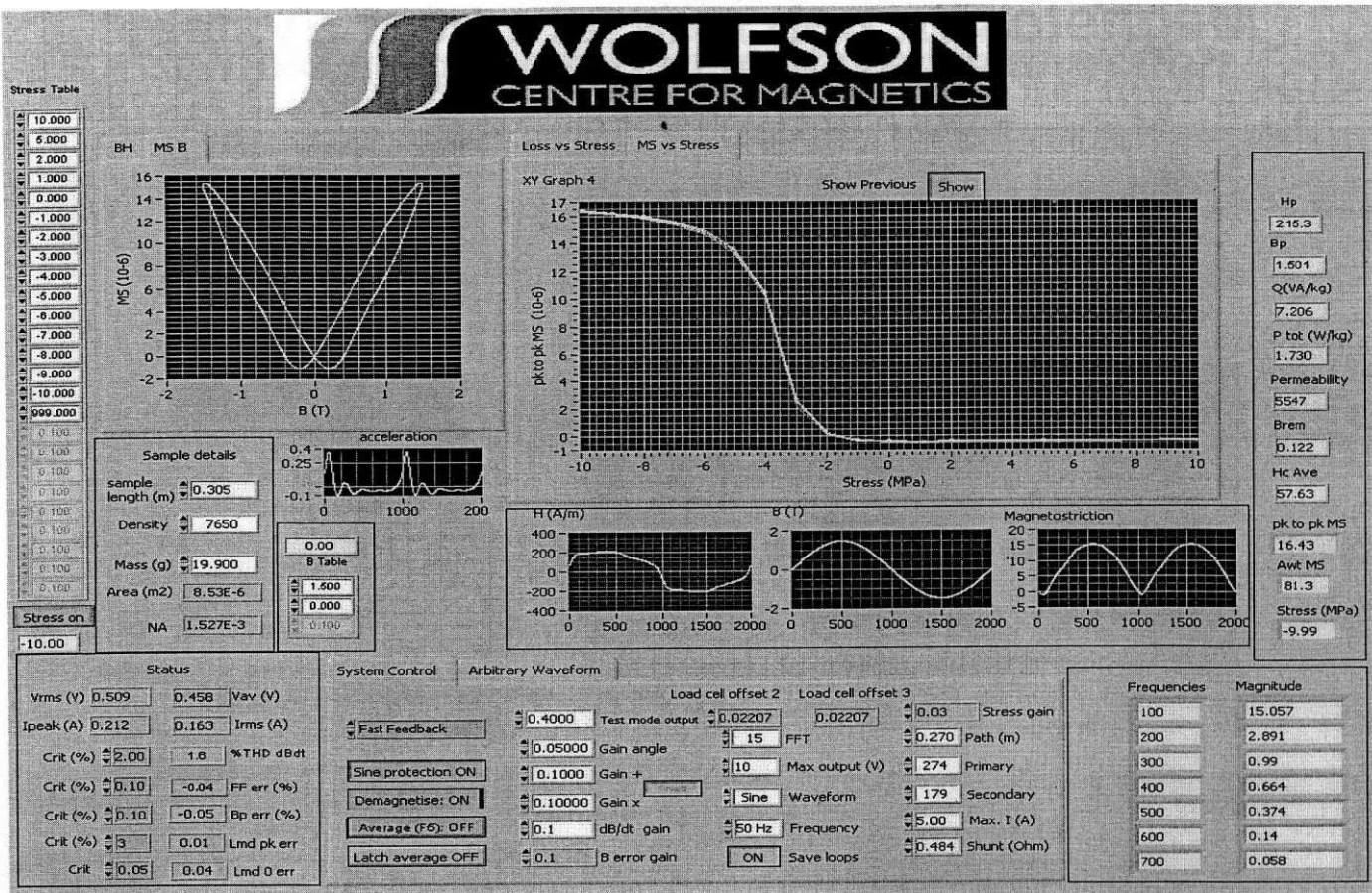


### ***Aims of the project:***

- ☐ ***Magnetostriction measurements on the current range of Cogent production materials (CGO, HiB and laser domain refined).***
- ☐ ***Evaluation of magnetostriction characteristics of laboratory produced tension coatings, include the effect of chemistry, coating thickness, surface profile and glass film grain size.***
- ☐ ***Produce a model to describe the magnetostriction versus stress sensitivity characteristic in terms of material, coating and process parameters.***

[illegible]





## Calculations of Magnetostriction

### Acceleration

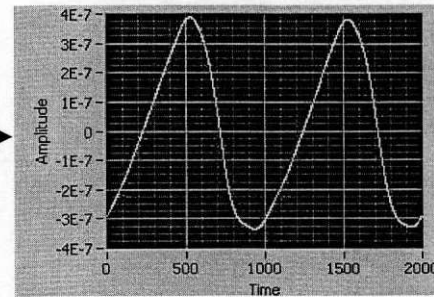
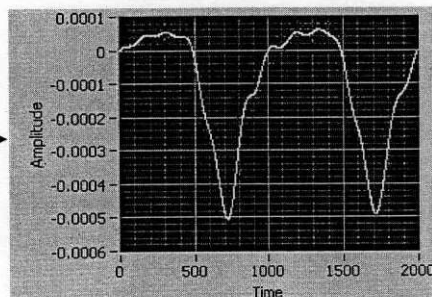
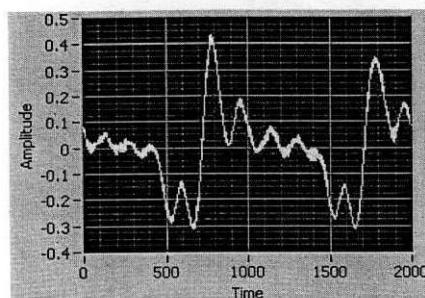
$$a(t)$$

### Velocity

$$v(t) = \int a(t) dt + C$$

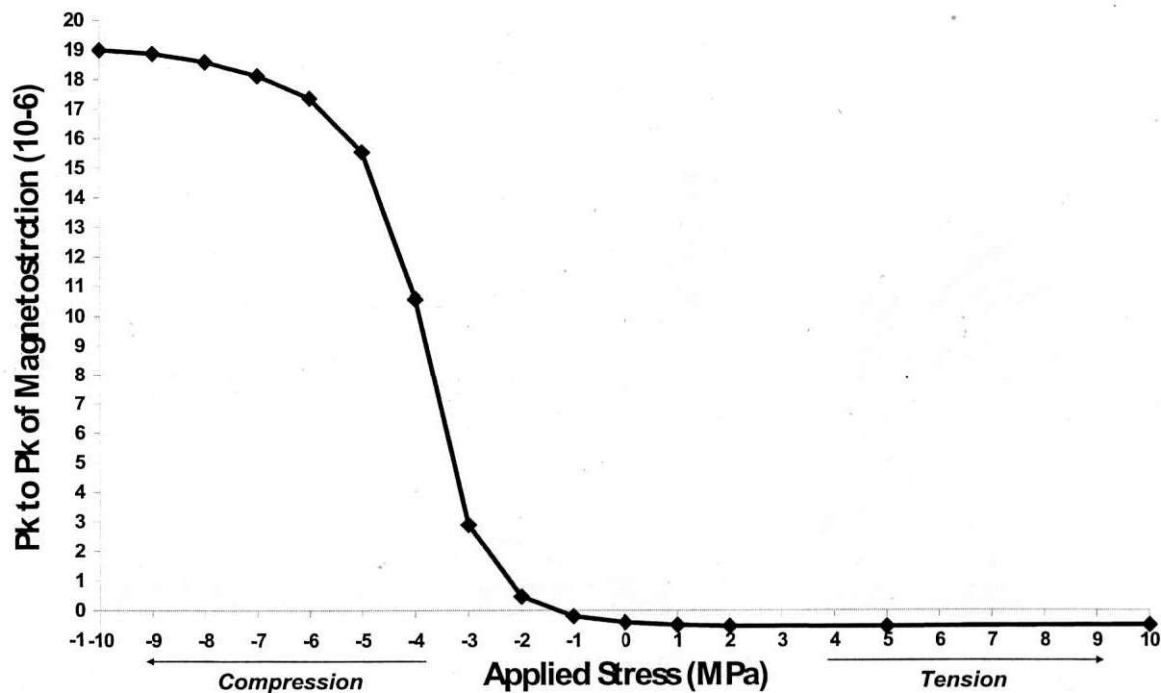
### Displacement

$$x(t) = \iint [a(t) dt + C] dt + C'$$



*The magnetostriction of the sample is calculated by double integration of the output of two piezoelectric accelerometers.*

## ***Typical magnetostriction versus stress characteristic of grain-oriented silicon steel***

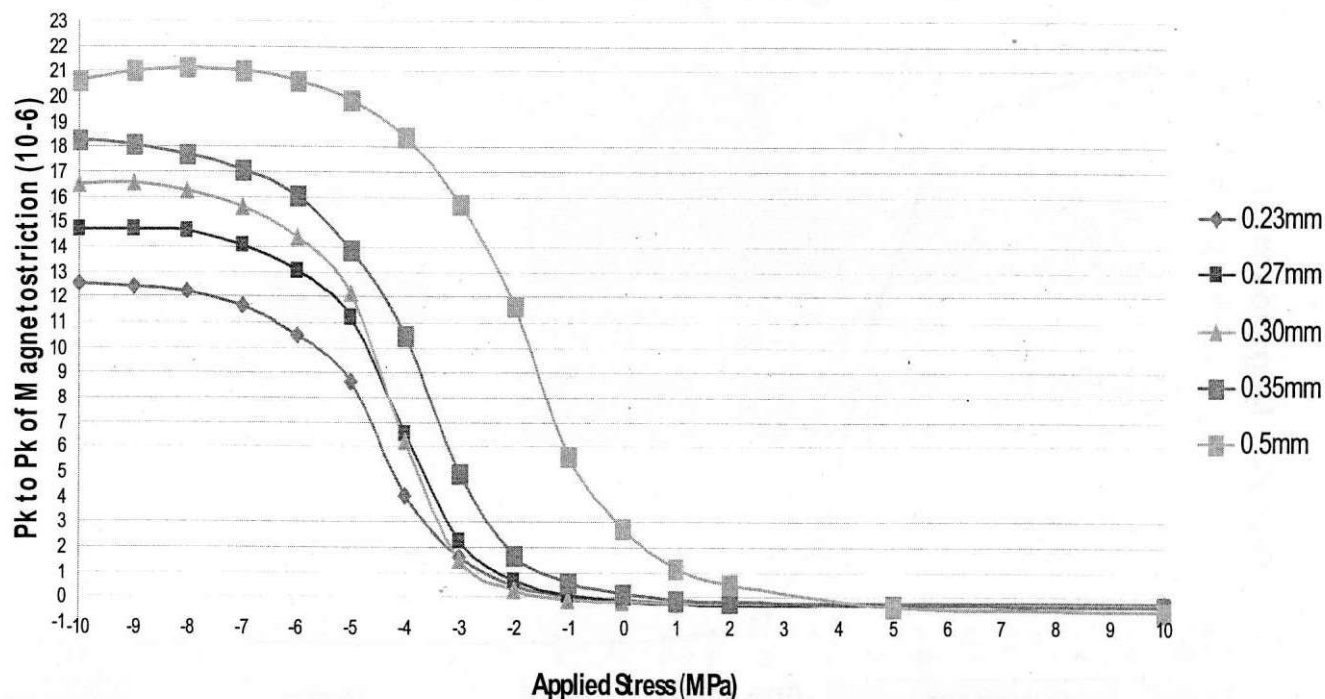


### ***Capability of the MMS***

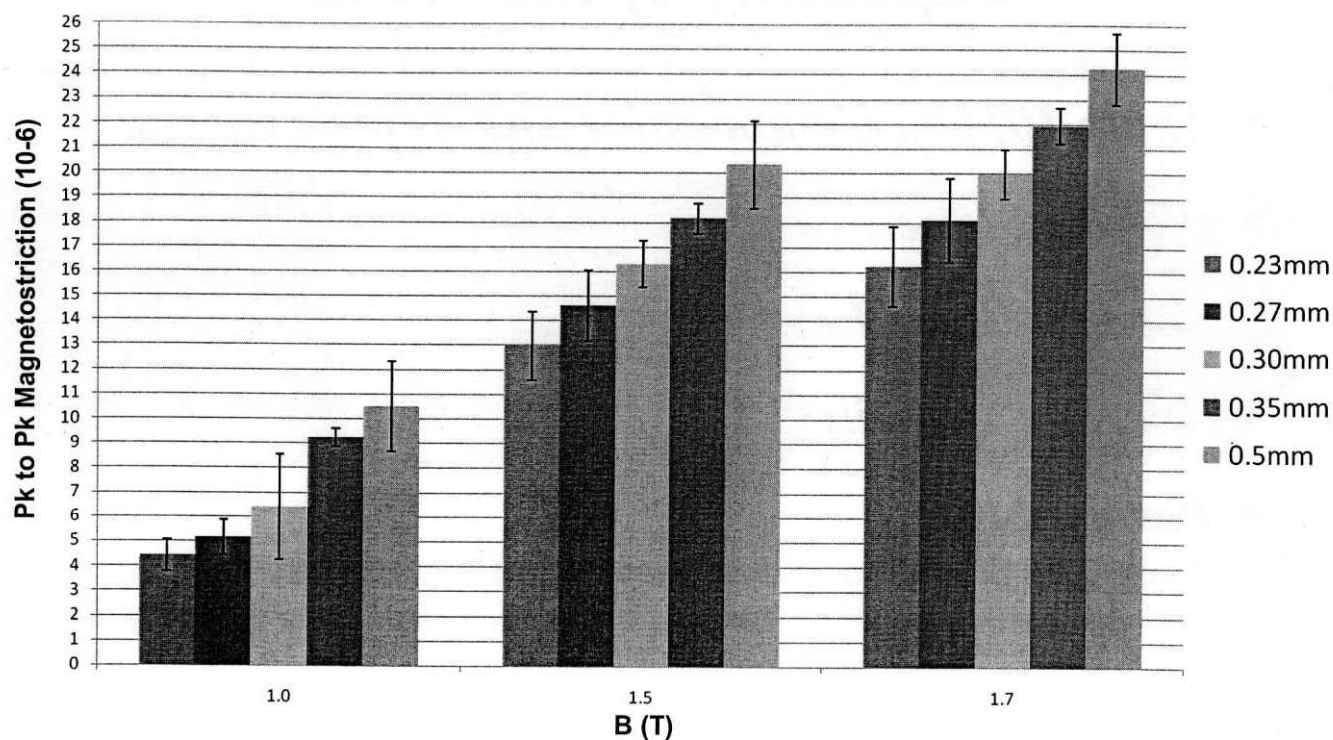
- ***Apply 10MPa Compressive and Tensile Stress***
- ***Pk-pk Magnetostriction***
- ***Specific Total Loss***
- ***Average Velocity***
- ***Permeability***



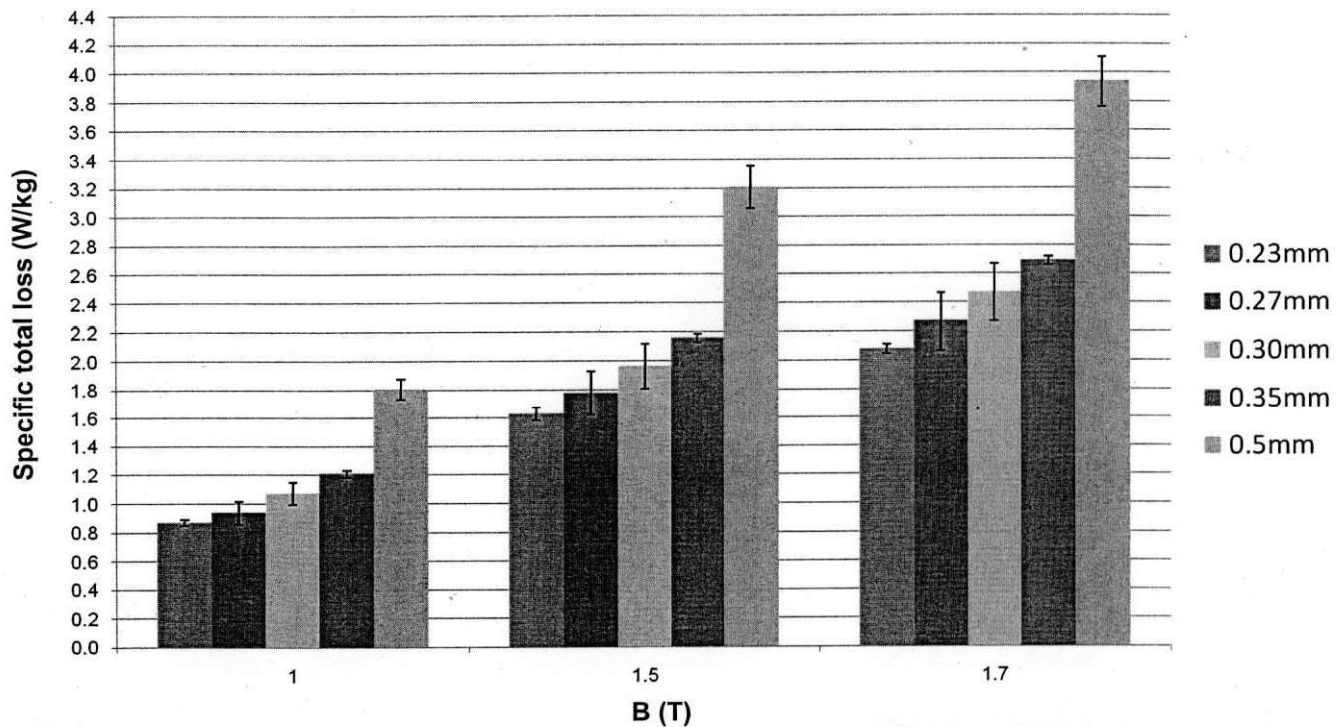
**CGO strips with different thicknesses magnetised  
under 50 Hz and  $B = 1.5T$**



**Thickness of the sample vs. Magnetostriction  
under -10MPa compressive stress, 50Hz**



**Thickness of the sample vs. Total loss  
under -10MPa compressive stress, 50Hz**



## **Summary**

- ❖ **A magnetic field applied along the rolling direction of grain-oriented electrical steel in the presence of a linear tensile stress, creates a small negative magnetostriction. In contrast, compressive stress is characterized by a rapid increase in magnetostriction.**
- ❖ **Magnetostriction measurement system was developed to rapidly and repeatably measure pk-pk of magnetostriction, specific total loss and permeability under  $\pm 10$  MPa of applied stress.**