

Opportunity

- *Industrially relevant steel and shape memory alloys undergo diffusionless (martensitic) transformations*
- *Martensitic transformations involve cooperative motion of large groups of atoms*

Challenge

- Events are intermittent and localized
- Current observation techniques provide before and after snapshots

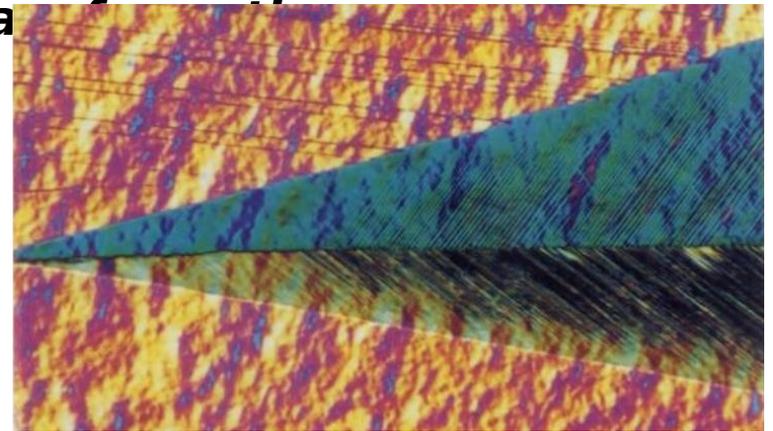
4GSR Strength

- Coherent beam provides localized information even with a large illumination area
- Microsecond probe of avalanche event dynamics
- Measurements relevant to fatigue

Collective Avalanche Events



Time resolution to resolve dynamics of diffusionless transformations



Spear of martensite (low T phase) penetrating the austenite (high T phase) during transformation.

Opportunity

- *Competing order leads to frustrated ground states in strongly correlated materials*
- *Fluctuations between equivalent ground states provide fundamental information on the competing interactions in such materials and are relevant to their stability*

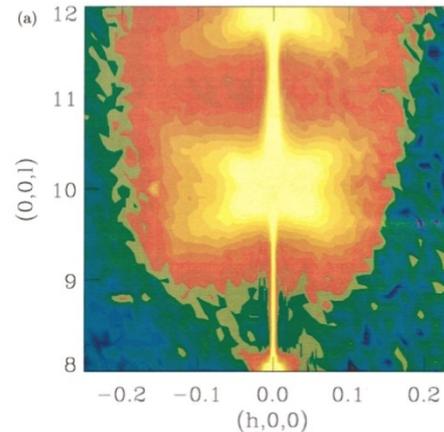
Challenge

- Environments such as low temperatures and strong magnetic and electric fields thwart measurements
- Small samples and surface effects complicate experiments

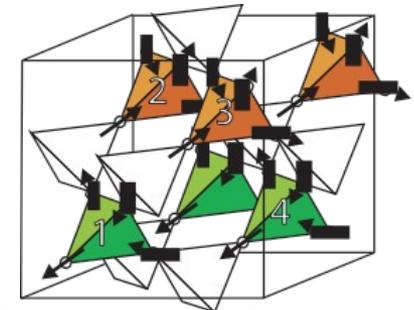
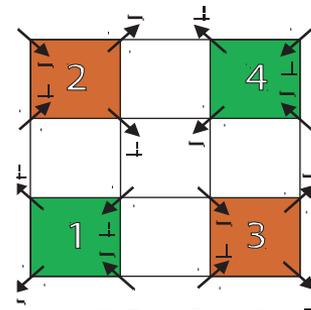
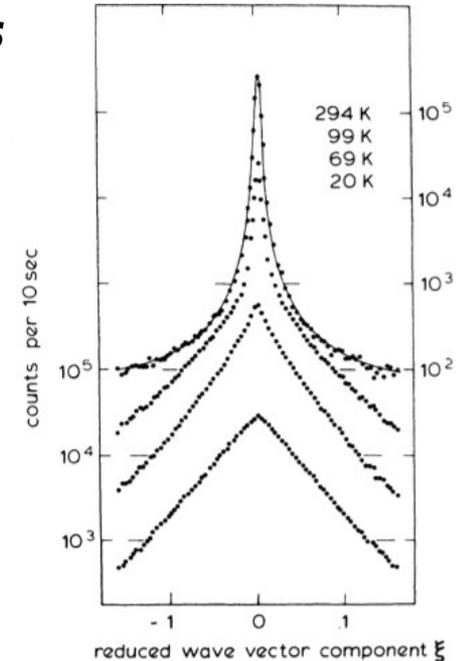
4GSR Strength

- High energy coherent beam accesses complex sample environments and measures

Competing Ground States in Orientational Glas



“Polaron” Hopping Dynamics



“Spin Ice” Frustrated Ground State

Dynamics Under Confinement

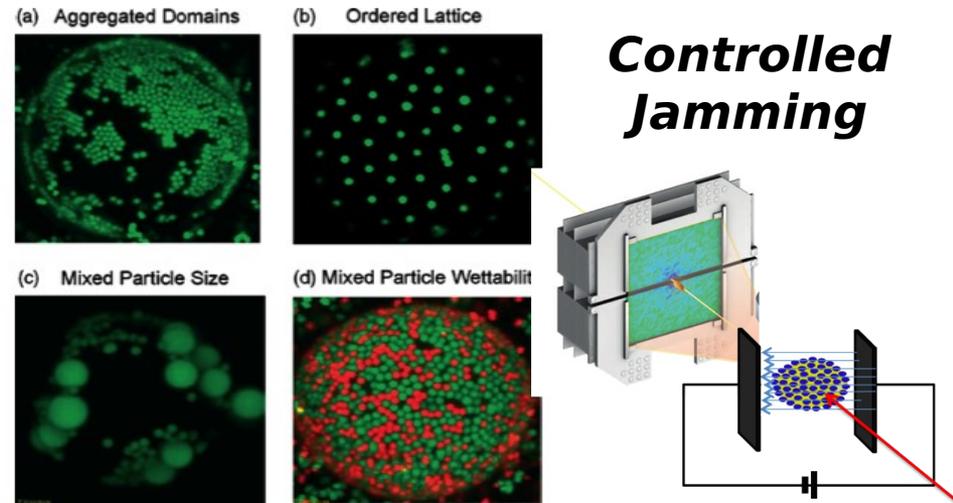
Opportunity

- Hierarchically ordered materials can provide a suite of engineered functionality such as artificial photosynthesis, media separation and emulsion stability (oil recovery) but the activity and stability of such materials is key to their use
- Microscale structure and stability of permafrost regions has significant environmental and industrial impact
- Engineered jamming and unjamming to control optical properties and chemical activity

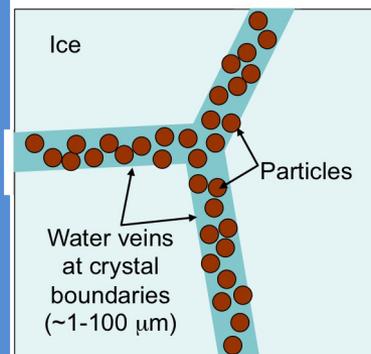
Challenge

- Dynamics over a broad span of timescales
- Dynamics measured in dense environments

Particle Dynamics at Interfaces Engineered Functionality



L. Dai et al., *Scanning* **30**, 87 (2008)



Thawing Permafrost