Developments in instrumentation and science at the ISIS pulsed neutron source

W.S. Howells

ISIS Facility, Rutherford Appleton Laboratory,

Chilton, Didcot, UK

Overview

- Instrumentation
  - GEM
  - IRIS
  - OSIRIS
- Science
  - quasicrystals
  - polymer electrolytes
  - fast-ion conducting glasses
- Future of RAL
  - ISIS second target station
  - new synchrotron

GEM

Second generation - replaced LAD

Dual function :

Powder diffraction - high resolution, high scattering angles

Disordered materials - wide Q range, lower scattering angles

High count rate

➨ spectra in 1 min

OSIRIS

Project will explore the instrumental horizons available with the cold neutrons from a pulsed source and especially the totally new avenues available to polarised neutrons on these sources

International collaboration : India, Italy, Spain, Sweden, Switzerland and UK

Phase I

Large d-spacing powder diffraction
Incident beam polarised powder diffraction

Phase II

High resolution spectroscopy $\Delta E = 25\ \mu eV$, $-0.8 < E < 5$ meV
Spectroscopy polarisation analysis   coh/incoh separation
Diffraction polarisation analysis

Quasicrystals

Dynamics in quasiperiodic alloys or quasicrystals (QC)

Investigate $Al_{50}Cu_{35}Ni_{15}$ alloy considered as 1-D QC

think of as CsCl structure with vacancies

Aim : investigate if atomic hopping at a large rate is restricted to taking place in systems with QC local order or if it exists more generally in metallic alloys at high temperatures

3 isotopic samples : n-n-n $^{N}Al^{N}Cu^{N}Ni$

n-n-0 $^{N}Al^{N}Cu^{0}Ni$

n-65-0 $^{N}Al^{65}Cu^{0}Ni$

QENS on IRIS

Quasicrystals : Conclusions

Both space and time evolvement of atomic motions are very similar to what has been found in alloys with QC or QC-like local order.

Frequent atomic jumps between interstitial positions are likely to take place on a ps time scale in any alloy above a certain relative vacancy concentration.

It is not a characteristic feature of QC.

Mechanism of atomic motions, at least in Al-based ternary compounds, is independent of their periodic or aperiodic structure.

Polymer electrolytes

Relation between mechanical and electrical relaxation in polymer/lithium-salt

Important bearing on the viability of such materials for use as electrolytes in lithium batteries.

Samples : PEO, $P(EO)_{7.5}LiClO_4$ and $P(EO)_{7.5}LiTFSI$

Structure **using SANDALS** PRL **84** 5536 (2000)

lithium ions coordinated with groups of ether oxygen atoms

Dynamics **using IRIS** Nature **405** 163 (2000)

two processes :

slow process with translational character

one or two fast processes with rotational character

Fast-ion conducting glasses

Structure using neutron & x-ray diffraction and RMC modelling

- **mixed alkali effect in $A_xB_{1-x}PO_3$ (A,B=Li,Na,Rb)**

  natural consequence when 2 kinds of alkali ions have distinctly

  different local environments which are preserved in mixed glass

- **immobile salt doping in $(PbI_2)_{0.19}$ - $(AgPO_3)_{0.81}$**

  dramatic increase in conductivity

  immobile Pb^{2+} ions almost entirely coordinated to non-bridging O

  introduced salt ions (particularly I) push neighbouring PO_4 chains apart

  more pronounced migration pathways for silver ions

RAL future prospects

ISIS Second Target Station

optimised for cold neutrons & high resolution spectroscopy

repetition rate 10 Hz (1 pulse in 5)

suite of 18 instruments

New Synchrotron

Funded by Wellcome Trust, British and French Governments

'Diamond' design - build by 2006

energies between 3 and 3.5 GeV

ring circumference about 400-500 m

up to 22 positions for insertion devices

➨ **World centre for condensed matter science**