• Introduction to CTS
• Introduction to Cathodic Protection
• Measuring the Effectiveness of Cathodic Protection
• CP Materials – some developments
• Remote Monitoring and Control
• Electrical Isolation
• Pipeline Surveys
Iraq End Users

Gazprom

Shell

LUKOIL Oil Company

SCOP

Ministry of Electricity

S.O.C
Accreditations
Agencies and Agreements

- Abriox – Remote Monitoring Systems
- Aegis – Switch Mode Power Supplies & Remote Monitoring and Control Systems
- De Nora Permalec – MMO anode for protection of Steel in Concrete
- Nuova Giugas, Italy – Monobloc Isolating Joints
- Rohrback Cosasco, USA – Internal Corrosion Monitoring
- SES Technologies – AC Interference Analysis Software
- Speir Hunter, UK – Stress Concentration Tomography (SCT) Pipeline Integrity Surveys
A full range of services...

- Consultancy
- Audit and Survey
- Design
- Materials Supply
- Installation Supervision
- Commissioning
- Maintenance Contracts (CP/Coatings/Corrosion Mon)
- Remote Monitoring and Control
- Training
Modelling of induced AC Voltages

- CTS are licencees of SES Right of Way Pro® software used for modelling induced AC voltages on pipelines and their mitigation

Computer modelling of CP systems

- CTS have a close relationship with BEASY (UK) who specialise in computer modelling of complex CP systems
Manufacturing facilities

UK, UAE, Saudi Arabia, Bahrain, India
What is Cathodic Protection?
Pipeline Corrosion Cell

What Causes the Potential Difference?
ELECTRO CHEMICAL CORROSION CELL

Electrolyte

Positive current flow

Electron flow

Anode: Fe(\text{OH})_2, \text{Fe}^{++}, \text{Fe}(\text{OH})_3

Anode potential: -600 mV

Cathode: \text{O}_2 + 4\text{OH}^- \rightarrow 2\text{H}_2\text{O} + \text{O}_2, \text{OH}^-

Cathode potential: -550 mV

Steel pipe wall
Cathodic Protection Cell

Anode (Corrosion)

Zn

2e\textsuperscript{-}  

Zn\textsuperscript{+2}

Cathode (Protection)

Fe

Electric Connection

I

Electrolyte
Practical Galvanic Series

- **Magnesium** - 1.75 Volts $(\text{Cu/CuSO}_4)$
- **Zinc** - 1.10
- **Aluminum** - 1.05
- **Carbon Steel** - 0.60
- **Cast Iron** - 0.50
- **Lead** - 0.50
- **Steel in concrete** - 0.20
- **Copper, brass,** - 0.20
- **Iron high silicon** - 0.20

Anode: Soil / Water

Cathode
Galvanic Anodes

Positive current lines

Sacrificial Anode

Electrolyte

Protected structure

I → e⁻

Positive current lines
Impressed Current

1. Energy source
2. Anode (inert)
3. Electrolyte
4. Positive current lines
5. Protected structure (cathode)
6. Applied energy source
7. Electron flow
8. Diagram showing the flow of energy and electrons.
Industrial Cathodic Protection

- Pipeline
- Tank bases
- Tank internal surfaces
- Plant piping
- Well casings
- Seawater intakes
- Condenser water boxes etc.
Tank CP – Distributed anode placement

Rectifier

Tank CP

Anode

Tank
Steel in Concrete

- Seawater intake & outfall structures
- Bridge/Jetty decks and soffits
- Building piles and foundations
- Seawater cooling towers
CATHODIC PROTECTION FOR STEEL IN CONCRETE

Existing Structures

New Build Structures
• Ghazlan II Power Plant
• Qurayyah Power Plant
• Louvre Museum Piles and Raft
Over 2 million sq. m. protected
Monitoring Cathodic Protection
Potential Across Metal/Electrolyte Interface
Check CP Levels with Reference Electrode

-850 Volts

CSE

Electrolyte

Pipe
Cathodic Protection Criteria

- Potential polarization $> - 0.85$ Volt (CSE)
- $100$ mV of polarization ($E_{off} - E_{nat}$)
- Net current measurements
- Corrosion coupons
- Other metals: $100$ mV polarization ($E_{off} - E_{nat}$)
- Polarisation Limit -1150mV (CSE)
Problems with Potential Measurement

- Unable to accurately measure ‘off’ potential
  - Synchronise interrupters
  - Coupons
  - RE close to structure
- Wrong measurement of natural potential when using 100mV criteria
  - Affected by galvanic couples, temperature etc.
Remote Monitoring and Control
Remote Monitoring

- Remote Monitoring of Power Supply outputs
- Remote Monitoring of Test Post Potentials
- Remote Monitoring of AC Corrosion

Monitoring and Control

- Includes Remote Control of power supply outputs
• Labour-intensive
• Poor utilisation of trained staff
• **Reactive** – no alarm to CP failures

• Safety issues
  • Many sites difficult to access
  • Lone working
  • Busy roadsides
  • Electrical safety
  • Environmental impact
  • H₂S Poisoning

• Costly
CTS Solutions

Remote Monitoring

- Abriox ‘Merlin’
- Aegis ARMS

Monitoring and Control

- Aegis ARMS
The MERLIN System allows you to remotely monitor the effectiveness of your CP system.
5 Channels for measuring
• AC Supply
• TR Output Voltage
• TR Output Current
• ON Potential
• OFF Potential

Synchronised Interruption for CIPS and DCVG surveys.
• Solid State (20-40A)
• Permanently installed
• Controlled by the MERLIN
• Activated from software or mobile phone
  • Full remote control
  • Synchronised interruption
  • CIPS & DCVG surveys
  • OFF Potential readings
  • Switch off TR output for maintenance
• 1 Channel
  • ON Potential

• 2 Channel
  • OFF Potential or 2nd ON Potential

• 3 Channel
  • Coupon Current

• Channels 1 & 2 require reference electrode; channels 2 & 3 require coupon
• SMS ("texting") is the recommended communication method
  • Proven and reliable
  • Low cost
  • Any GSM network can be used
  • In-country or international roaming

Satellite communication is used in remote areas where there is no GSM signal
  • Full global coverage
  • Low latency (messages received quickly)
  • Requires Internet connection with software
iCPSM (Internet-based Cathodic Protection System Manager)

- Database software package
- PC-based and Web-based user interfaces
- Displays, archives and exports CP data
- Full remote control of MERLIN monitors
- Configurable alerts
2012 saw Abriox win the Queen’s Award for Enterprise

The Queen's Award for Enterprise is the most prestigious corporate accolade that a UK business can win and is a credit to the hard work of everyone in Abriox over several years.

This prestigious Award has been granted for the company’s highly innovative MERLIN Remote Cathodic Protection Monitoring System.

The Press Release citation stated: "As a consequence of Abriox’s innovation, monitoring staff safety and efficiency have improved significantly and their carbon footprints have been reduced. MERLIN is the world’s leading system of its type and has led commercial success for the company."
Who uses Merlin products?

UK
- Esso, Shell, BPA
- All the gas companies
- Gas power stations
- Chemical companies

United States
- Colonial Pipeline
- Duke Energy
- Buckeye
- Northwestern Energy
- Kinder Morgan
- Williams Gas

International Projects
- France
- Ireland
- Uruguay
- Pakistan
- United Arab Emirates
- Libya
- Nigeria
- Kazakhstan
Global Experience

Total 8500 units in operation

• Eight gas distribution networks in UK - Total of 280,000km

• Six Major US Operators

• UK National transmission system
  • 6 coastal reception terminals
  • 2 LNG import terminals.
  • This comprises of nearly 8,000km of large diameter pipeline

• BTC Azerbaijan-Georgia Pipeline 60 units

• Successful trials in UAE with DUSUP, TAKREER, ADCO, GASCO
AEGIS Remote Monitoring System
Differences from Abriox Merlin

- Remote CONTROL of suitable Power Supplies is possible
- Signals transferred over Hard-wire network (RS485 or Fibre Optic)
- Not available for remote test posts
ARMS
AEGIS Remote Management System

Internet Users
Engineers, Specialists, Operators

Mobile Users
Duty Officer

PDA Users
Field Technician

Laptop user
Maintenance

Intranet Users
Engineers, Specialists, Operators

CU
LAN

Replica CU
Firewall

www
Internet

More
LUs

More
LUs

More
LUs

Nippon TRU
Nippon Ref
Electrotech TRU
Nippon TRU
Nippon Ref
CTS/Aegis TRU
CTS/Aegis TRU
CTS/Aegis TRU

Nippon TRU
Nippon Ref
Nippon Ref
Nippon Ref
Nippon Ref
Nippon Ref
Nippon Ref
Nippon Ref

CTS/Aegis TRU
CTS/Aegis TRU
CTS/Aegis Ref
CTS/Aegis Ref

RS485

Existing Structures
Tank Area
Plant Piping
Background
The Project Sample substructure and foundation will be constructed on a reclaimed shore area of Dubai Creek. This is an aggressive environment in terms of reinforcing steel corrosion and its effect on structural durability in the long-term.

Target Structures
Target structural components include the foundation piles, base slab, and perimeter walls of the seawater intake structure, the outfall and outfall channel, and the desalination plant. Full details are in the O&M manual (click on Help & Reference in the menu at the left).
# Aegis Remote Monitoring and Control System (ARMS)

**Sample System A101**

**Industrial Facility Company Limited**

## System Settings: TR

### Seawater Intake

<table>
<thead>
<tr>
<th>Rating</th>
<th>Reference potentials</th>
<th>Present output</th>
<th>Setpoints</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mV</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>mV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TR1</td>
<td>24</td>
<td>2.4</td>
<td>5.5</td>
</tr>
<tr>
<td>TR2</td>
<td>24</td>
<td>3.0</td>
<td>5.5</td>
</tr>
<tr>
<td>TR3</td>
<td>24</td>
<td>2.8</td>
<td>5.5</td>
</tr>
<tr>
<td>TR4</td>
<td>24</td>
<td>3.1</td>
<td>5.5</td>
</tr>
</tbody>
</table>

### Outfall

<table>
<thead>
<tr>
<th>Rating</th>
<th>Reference potentials</th>
<th>Present output</th>
<th>Setpoints</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mV</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>mV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TR1</td>
<td>24</td>
<td>2.9</td>
<td>5.5</td>
</tr>
</tbody>
</table>

The screenshot shows the monitoring system settings, including seawater intake and outfall, with various ratings, reference potentials, present output, and setpoints.
Cathodic Protection Materials

Anodes

Cables
Magnetite Anode Details

Magnetite element  Lead layer  Porous polystyrene body  Centre connection  Sealing compound  Anode cap

Compression sleeve  Cable

MMO COATED TITANIUM TUBULAR ANODE 25.4 x 0.9 THICK

25.4 500

PLUG  CONNECTOR  EPOXY FILLING

16Sq.mm KYNAR/HMWPE CABLE 20m LONG (BLACK)

MMO TUBULAR ANODE DETAILS
<table>
<thead>
<tr>
<th>MAGNETITE</th>
<th>MMO</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Composition:</strong></td>
<td>Composition:</td>
</tr>
<tr>
<td>Oxides of iron (Fe$_3$O$_4$ and Fe$_2$O$_3$)</td>
<td>Oxides of Iridium, Tantalum, Ruthenium</td>
</tr>
<tr>
<td>for seawater use only</td>
<td>(for sea water use only)</td>
</tr>
<tr>
<td><strong>Consumption Rate:</strong></td>
<td>Consumption Rate:</td>
</tr>
<tr>
<td>0.2kg/Ayr</td>
<td>1mg/Ayr</td>
</tr>
<tr>
<td><strong>Usage restriction:</strong></td>
<td>Usage restriction:</td>
</tr>
<tr>
<td>Good in chloride containing environments.</td>
<td>None in normal natural environments.</td>
</tr>
<tr>
<td>Failures have been found in clay soils</td>
<td>Ruthenium should not be included in anodes</td>
</tr>
<tr>
<td>to be used where chlorides are not present.</td>
<td></td>
</tr>
<tr>
<td><strong>Production:</strong></td>
<td>Production:</td>
</tr>
<tr>
<td>Magnetite is a difficult material to use as an</td>
<td>Production is relatively easy and the MMO</td>
</tr>
<tr>
<td>anode. Anodes must be cast or sintered.</td>
<td>coating can be applied to a prepared titanium</td>
</tr>
<tr>
<td>Magnetite is a relatively high resistance</td>
<td>tube by thermal decomposition of plasma spray</td>
</tr>
<tr>
<td>material and the anode is lined with lead to</td>
<td>processes. Titanium tube ensures good current</td>
</tr>
<tr>
<td>improve current distribution. The anodes are</td>
<td>distribution.</td>
</tr>
<tr>
<td>bulky.</td>
<td></td>
</tr>
<tr>
<td><strong>Cable connection:</strong></td>
<td>Cable connection:</td>
</tr>
<tr>
<td>Cable connection is made to the lead lining.</td>
<td>Cables can be centrally connected by several</td>
</tr>
<tr>
<td>This is not an easy process and the connection</td>
<td>methods which results in a cable to anode</td>
</tr>
<tr>
<td>is not as strong as for MMO anodes. It is often</td>
<td>connection stronger than the connecting cable.</td>
</tr>
<tr>
<td>recommended that the anodes are supported in</td>
<td></td>
</tr>
<tr>
<td>semi-deep or deep groundbeds.</td>
<td></td>
</tr>
<tr>
<td><strong>Handling:</strong></td>
<td>Handling:</td>
</tr>
<tr>
<td>Magnetite is a brittle material and must be</td>
<td>Anodes are robust. Dropping an anode will</td>
</tr>
<tr>
<td>handled carefully. The anode core is filled</td>
<td>not damage it.</td>
</tr>
<tr>
<td>with a polystyrene filler to help absorb</td>
<td></td>
</tr>
<tr>
<td>shocks. The anode will probably break if</td>
<td></td>
</tr>
<tr>
<td>dropped or banged.</td>
<td></td>
</tr>
<tr>
<td><strong>Thermal shock:</strong></td>
<td>Thermal shock:</td>
</tr>
<tr>
<td>Magnetite can crack if exposed to</td>
<td>No effect.</td>
</tr>
<tr>
<td>temperature extremes.</td>
<td></td>
</tr>
<tr>
<td><strong>Use:</strong></td>
<td>Use:</td>
</tr>
<tr>
<td>Anodes can crack due to stressed from gasses</td>
<td>Few practical limitations. The often quoted</td>
</tr>
<tr>
<td>produced in use if there are</td>
<td>10-12 V breakdown voltage of titanium is not</td>
</tr>
<tr>
<td>imperfections in the casting.</td>
<td>generally applicable to MMO coated anodes.</td>
</tr>
<tr>
<td><strong>Cost:</strong></td>
<td>Cost:</td>
</tr>
<tr>
<td>6 times MMO</td>
<td>Cheaper than magnetite</td>
</tr>
<tr>
<td><strong>Availability:</strong></td>
<td>Availability:</td>
</tr>
<tr>
<td>Available only from one manufacturer</td>
<td>Available from a number of reputable sources</td>
</tr>
</tbody>
</table>
Magnetite anodes fail!
Use Fluorcarbon cable in Deep Groundbeds
ISOLATION OF PROTECTED STRUCTURES

Isolating Joints and their Problems
There are substantially 3 PRIMARY sealing systems nowadays adopted by the manufacturers of monolithic isolating joints

- **O-Ring sealing system**
- **Rectangular shaped sealing system**
- **U – shape sealing system**
- **Internal Insulation**

Above systems show vital differences and service limitations that engineers should be aware of.
O-Ring system

It is a primary sealing system made of 2 or 4 O-Rings counter opposition between metal and isolating only. It originates directly from the traditional system of the isolating flanges and therefore it hasn’t been specifically studied for the monolithic isolating joints.
The primary sealing system consists of a rectangular shaped gasket hardly compressed among the metallic surfaces and the metal and the isolating spacer. It is a sealing system specifically studied for the monolithic isolating joint.
U-shape sealing system

This sealing system is “built” around the rigid isolating spacer and is made of a symmetric U shaped gasket with double profile, tightly compressed in a proper space obtained in the metallic components. It is a sealing system specifically developed for the monolithic isolating joint and it is commonly referred to as “DSGS” (Double Seal Gasket System).
O-Ring system

Among all possible effects that could happen, the worse is “fluid leakage”. Let’s see why this happens with O-ring joints.
O-Ring system

The dimension of O-Ring is small in purpose for voiding the phenomenon of explosive decompression. A structural deformation (expansion, distortion or compression) of few decimals of millimeters can cause a leakage (for instance: only 0.2mm per O-ring of 4mm). Also, the O-ring can become permanently distorted.

Critical spread > 0.2mm
(Fluid infiltration)

MAX bearable detachment without leaking=0.2mm

\( \phi \ OR=4\text{mm} \)

Compression=0.8mm (20%)
What illustrated has been taken for granted by several specifications that forbid or limit use of O-ring in the manufacturing of isolating joints.
O-Ring sealing system

Nuova Giungas fully removed O-ring from production of monolithic isolating joints at the end of the 70s, deciding back then to invest on research and development aimed to more efficient solutions and specifically studied.
RECTANGULAR sealing system

In fact the pressure laps the gasket at point A and A₁ generating these effects:

- Amplifies the bending moment pushing on the crown of flanged component.
- Increases the longitudinal tensile stress caused by the high pressure circle of application.
- Shrinks the gasket at point A₁ reducing the space fluid has to make before shortening.
Nuova Giungas limited the production of isolating joints, with this sealing system, to pressures up to 200 Bar. Also, for diameters over 20”, the isolating spacer has to be made with an innovative method that brings it together with the metallic component to obtain a single piece to avoid the missing compensation previously mentioned. Although, this method can’t be illustrated, because covered by a strict industrial secret.
U-shape system

This system has been originally used for highest pressure services (1000 Bar), but then and after verifying the success obtained, the use has been extended to the whole production of monolithic isolating joints, standard ones included. The very high investment in search of materials, equipments and moulds has been satisfyingly paid back by the worldwide success.
U-shape sealing system

The gasket proportionally reacts against the pressure, opposing the fluid by autho-energizing itself. Also, it isn’t subject to the explosive decompression phenomenon, being fully surrounded by a proper restraining chamber and it is a matter of fact that can’t change its shape.

To date we have manufactured isolating joint’s models suitable to be taken at test pressure up to 1500 Bar and they are hundreds the isolating joints installed all over the world working at pressures up to 1000 bar and are several thousands the isolating joints manufactured for more conventional pressures (up to 100 Bar).
Conclusions

- Service of *O-ring* type seal Joints shall be limited to low pressures, small diameters and to pipelines without bending, tensile, torsion and compression loads.

- Service of Rectangular type seal Joints shall be limited to medium high pressure. Highest pressures (over 300 Bar) to be void.

- **There are no service limitations to** *U-shape* type seal Joints.
In traditional joints, the longitudinal isolating systems against the fluid and the surrounding soil, are given by **protective isolating coatings and linings**. Although, the performance of these coatings and linings could decrease with time (erosion, chemical attach, etc...) especially if fluids and soils are very aggressive and/or the temperatures are very high, or simpler and more frequently if isolating joint get damaged at job site during installation.
INTERFERENCE ACROSS AN ISOLATING JOINT

- Corrosion
- Current 'jumps' across isolation through water
- Insulation
- Protected side
- Unprotected side
- Water corrosion
<table>
<thead>
<tr>
<th>Pipeline ID</th>
<th>Potential (mV Cu/CuSO₄)</th>
<th>Current Measured by Swain Meter (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Protected Side</td>
<td>Unprotected Side</td>
</tr>
<tr>
<td>6”-GI-10</td>
<td>1206</td>
<td>602</td>
</tr>
<tr>
<td>10”-GI-11</td>
<td>1488</td>
<td>608</td>
</tr>
<tr>
<td>12”-EG-01</td>
<td>1486</td>
<td>605</td>
</tr>
<tr>
<td>12”-LG-01</td>
<td>1489</td>
<td>602</td>
</tr>
<tr>
<td>6”-WI-01</td>
<td>1202</td>
<td>612</td>
</tr>
<tr>
<td>20”-EXP-01</td>
<td>1210</td>
<td>603</td>
</tr>
<tr>
<td>10”-GI-01</td>
<td>1312</td>
<td>604</td>
</tr>
<tr>
<td>10”-MG-01</td>
<td>1302</td>
<td>605</td>
</tr>
<tr>
<td>10”-GI-02</td>
<td>1306</td>
<td>602</td>
</tr>
<tr>
<td>20”-TL-01</td>
<td>1312</td>
<td>604</td>
</tr>
<tr>
<td>20”-TL-02</td>
<td>1306</td>
<td>605</td>
</tr>
<tr>
<td>6”-WI-02</td>
<td>1206</td>
<td>612</td>
</tr>
<tr>
<td>8”-WS-01</td>
<td>1100</td>
<td>614</td>
</tr>
<tr>
<td>6”-DL-01</td>
<td>900</td>
<td>616</td>
</tr>
</tbody>
</table>
NG developed a new integrated transversal and longitudinal sealing system. This system is in perfect harmony with the metallic structure and without junction points, therefore not bypassable by the electrical current.

It could be used alone, or together with the more conventional/traditional isolating coatings and linings, to perform in the most severe operating conditions.
NGx/C isolating joint type

Double seal gasket system

Trasversal insulation system

External longitudinal insulation system

Internal longitudinal insulation system

NGPR0502
Section through Joint
Pipeline Integrity Services

- **CP audits**  
  Check the condition of existing CP systems

- **CIP/DCVG surveys**  
  Check CP levels and coating quality

- **SCT surveys**  
  Check for stresses concentrations

- **PCM surveys**  
  Check coating quality

- **ECDA Studies**  
  Inspection and analysis survey
Close Interval Survey

- Voltmeter
- CSE
- Electrolyte
- Pipe
TYPICAL CIPS/DCVG DATA PLOTS
Coating Damage
Current flow to pipe with defects

Large "Impressed" Current Flowing Directly to Holidays/Defects
DCVG Procedure
DCVG Results
AC Attenuation (PCM)

Useful where there is no voltage gradient

- Impose AC
- Measure electronic current down pipeline
  - Magnetometer tuned to frequency
- Current is drained when coating is damaged
Typical PCM Data
REMOTE MEASUREMENT OF STRESS IN FERROMAGNETIC PIPELINES

STRESS CONCENTRATION TOMOGRAPHY OF PIPELINES
NON-CONTACT MAGNETIC MEMORY METHOD OF INSPECTION OF PIPELINES

Objective
A non-invasive, remote inspection method requiring no pipeline preparation procedures and no change to operating parameters. Capable of delivering a report on location of abnormal stresses, the metallurgical and mechanical conditions causing the stress, MAOP and Safe Operating Term.

Magnetostriction
Change in dimensions of ferromagnetic material when subjected to a magnetic field. Identified in 1842 by James Joule.

Longitudinal Magnetostriction

Villari Effect
Inverse of longitudinal magnetostriction. Change in magnetic susceptibility in response to an applied stress on the material, i.e., stress causes an increase or decrease in the residual magnetic field (magnetic memory effect).
SCT PRINCIPLES

No Defects

With Defects
Shape, strength and direction of magnetic field vectors determined by the intensity and extent of stress.

Field generated by pipeline stress decays with distance from pipe.

Data collection to 15 x pipe diameter.
SAME DEFECT SIZE –
Which is more likely to cause failure?

Plastic Deformation

SCT detects and measures ALL the mechanical stresses in a section
Areas of stress extend beyond the dimensions of physical features
Summary of Inspection Methods

- **Potential Measurement** – measures ‘spot’ potentials. Good for routine maintenance
- **CIP Survey** – measures Pipe Potentials along the pipe length
- **DCVG/PCM** – Detect coating defects
- **SCT** – Detects stresses in pipelines and likely points of failure. Useful for unpiggable lines and survey of short sections where problems are suspected.
Who is Currently using SCT?

- National Grid UK – 2 year programme
- Enbridge Canada 17.5km
- PDO Oman 38km
- TIGF France – 31 sites
- Shell Nigeria
Audit, Investigation, Surveys
Pipeline Integrity, ECDA
FEED Studies, Design Documents
Materials Supply/Installation
Long-term Maintenance
CP, Corrosion Monitoring, Coatings
Thank you for listening

Questions?