

# Potential Applications of Geopolymer Technologies in Hong Kong

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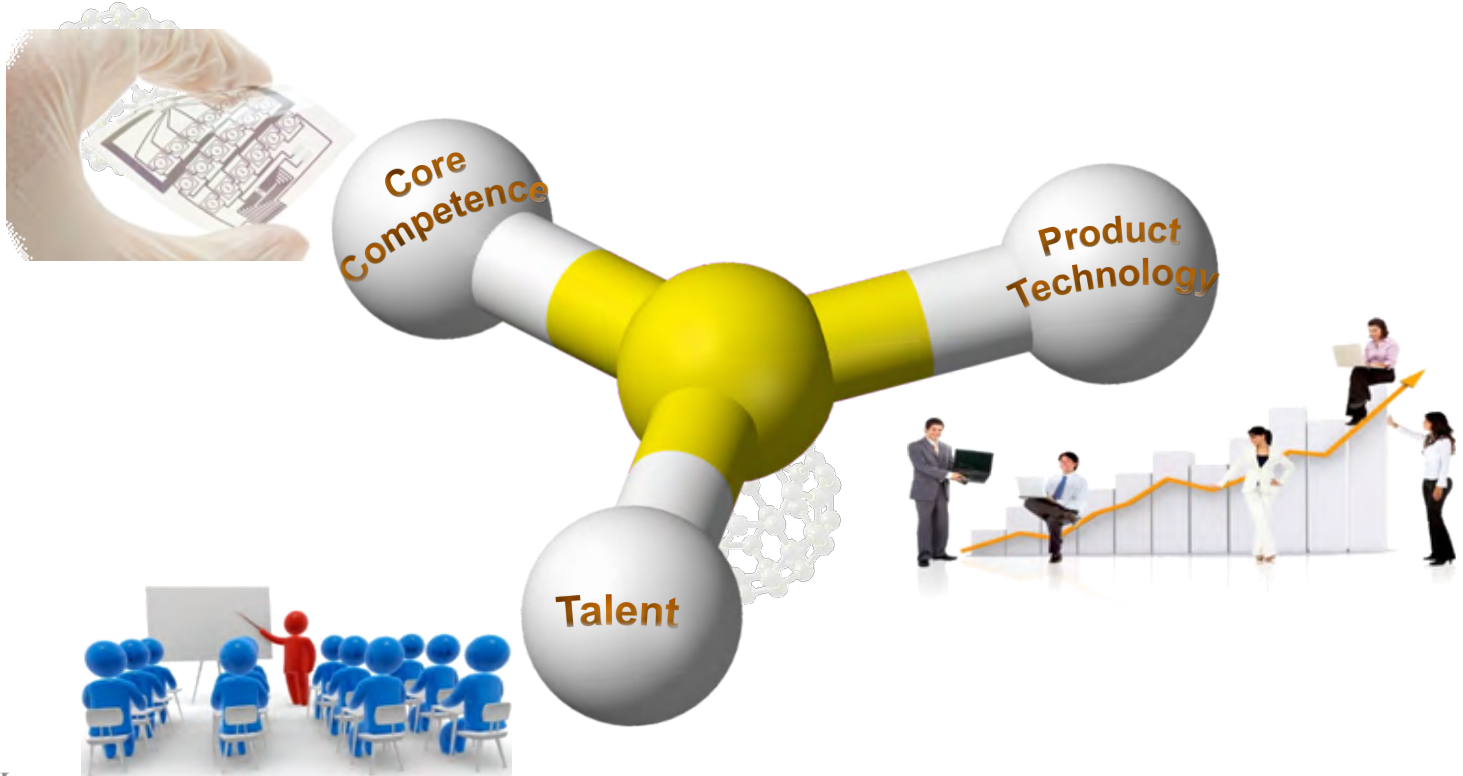
# Why Hong Kong?

- Strategically located at the heart of Asia, and alongside **most exciting material markets**
- Abundant feedstock supplies from China, such as metakaolin, fly ash, slag, etc.
- **Opportunities** for “new” building materials
- Renowned worldwide **financial center**
- Legal protection of **intelligent properties (IPs)**



# NAMI – an Applied Research Centre

- NAMI is established in 2006 by HK Government
- **Filling the gap** between research & applications
- Offer **technology upgrade** of HK industries

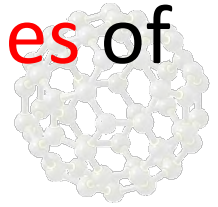


# Concrete Usage in HK



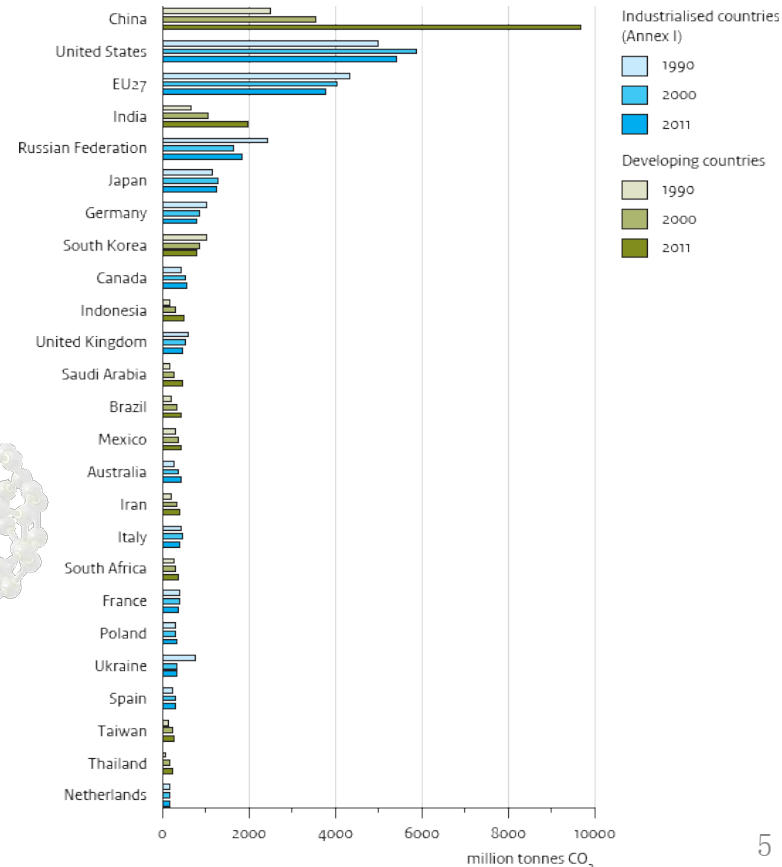
Your Materials Expert

- Annual consumption per person is **~5 times** of the world average



# Carbon Footprint of Cement

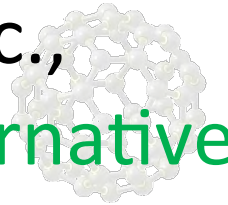
- The cement industry creating **more than 5%** of worldwide greenhouse gas CO<sub>2</sub> emission
- **One third of this** was produced in Asia



- Urgent & local need for eco-friendly **alternatives**

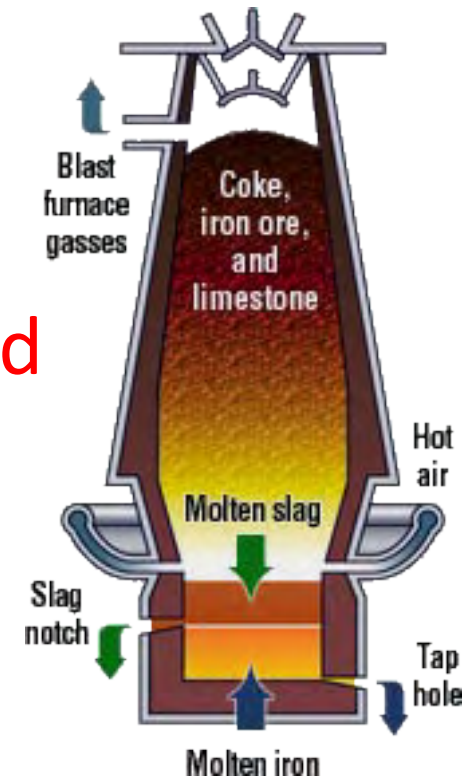
# Geopolymer Technology

- Utilizing metakaolin, slag, fly ash, clay, etc., **geopolymer cement** (GpC) is a **green alternative**
- Unique features including
  - **Rapid early strength**
  - **Acid resistant**
  - **VOC free**
- Geopolymer based materials (GpM) can be tailored for different **application scenarios**
- Contributes to the sustainable development & **supported by government funding**



# Recycling by Geopolymerization

- Ground granulated blast-furnace slag (GGBS) is a **by-product of iron and steel-making**
- Annual production in China only is about **15~20 million tons**
- With geopolymer technology, GGBS can be **recycled & polymerized** to develop binding strength
- A **win-win solution** to the environmental issues



# Rapid Repair of Highways

- Demand for cost effective rapid repair materials for **urgent & emergency cases**
- Advantage over organic repair materials
  - **Applicable on wet surface**
  - **Utilizing recycle materials**
  - **Much lower cost**
  - **VOC free**





# Maintenance of Sewerage System

- Concrete sewers under attack by **sulfuric acid**
- Rehabilitation and improvement program
- **A huge demand for sewer maintenance**
  - Patch repair, sacrificing layer, repair lining, etc.
- Excellent chemical & **corrosive resistance**



# Precast of Non-Structural Units



- With a variety of products & design options, precast concrete units are widely used in the construction industry
- **Geopolymer based materials (GpM)** offers eco-friendly solution to the precast industry



# Structural Use in China



A 6-storey office & retail building

# Structural Use in China

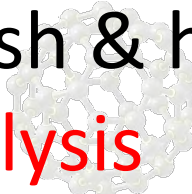
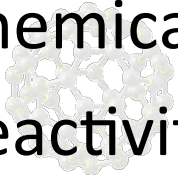
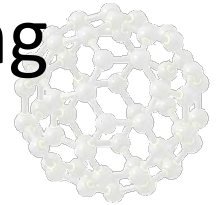


Beams & columns of a workshop

# Development of GpM in NAMI

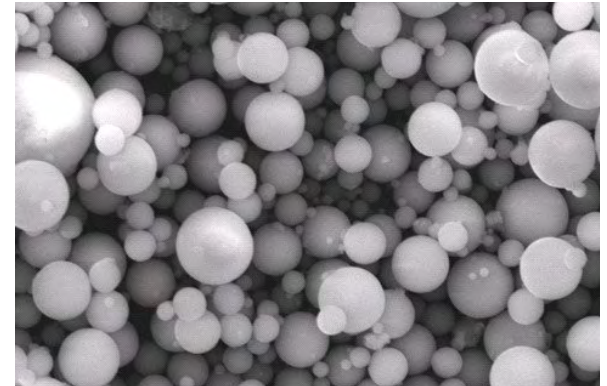


- GpM formulation & optimization targeting different **applications & collaborations**
  - Alkalinity & types of activator
  - Chemical admixtures & inert fillers
  - Reactivity of raw materials such as metakaolin, slag, fly ash, clay, etc.
  - Functional materials
- Physical, chemical, fresh & hardened properties, **durability & micro analysis**
- Different forms in paste, mortar, concrete & **fiber reinforced GpM**

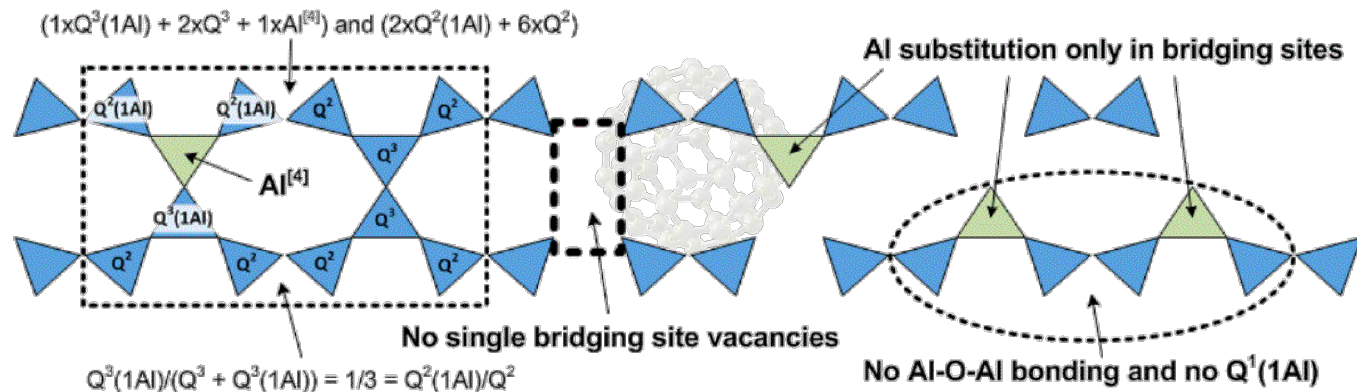


# Nano Modification

- Nano-particles to be utilized for micro-strengthening
  - Carbon nanotube, nano clay, nano silica, etc.

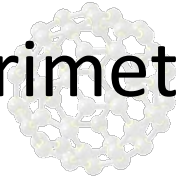


- A realistic molecular structural model to be established facilitating further development



# Materials Characterization

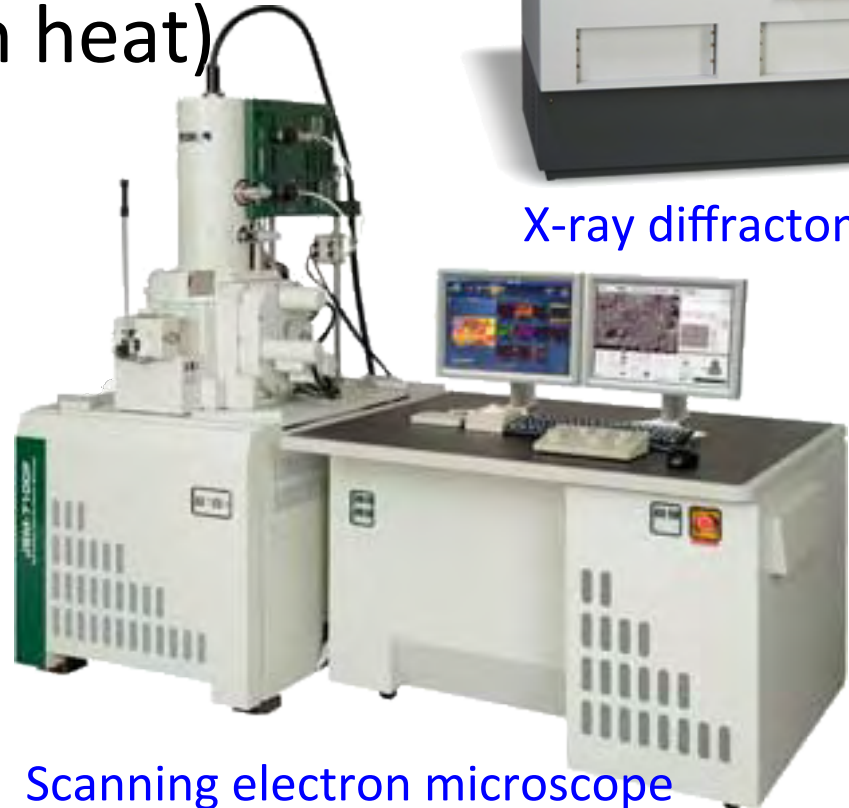
- Particle size distribution
- Phase identification (XRD)
- Surface morphology (SEM)
- Calorimeter (reaction heat)



Particle size analyzer

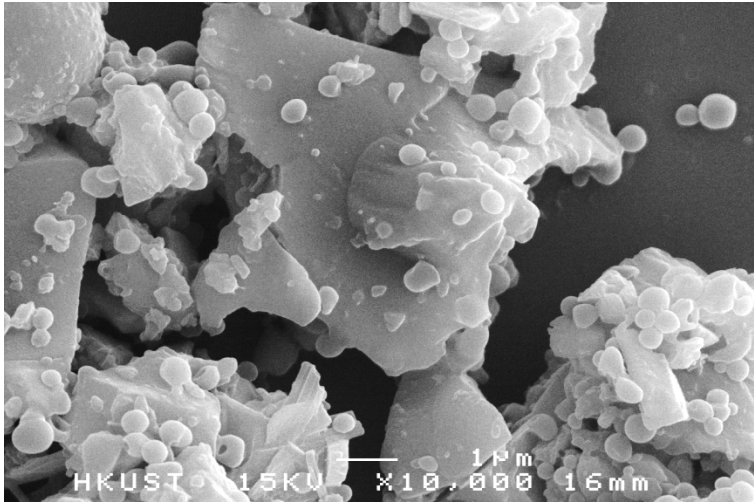


X-ray diffractometer

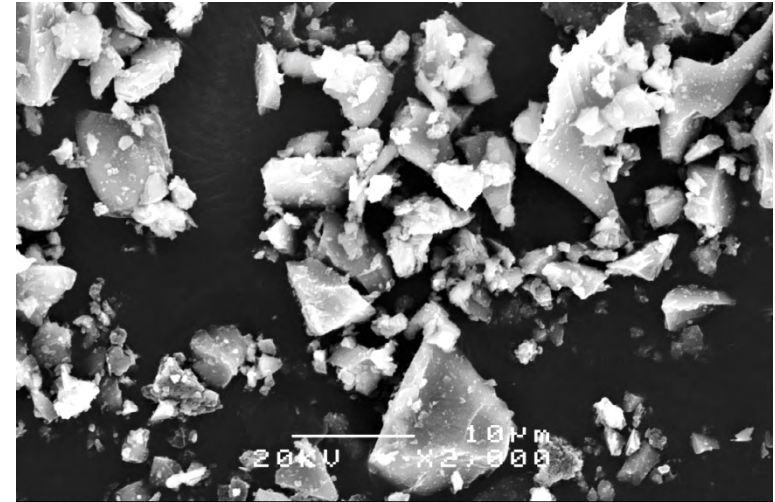


Scanning electron microscope

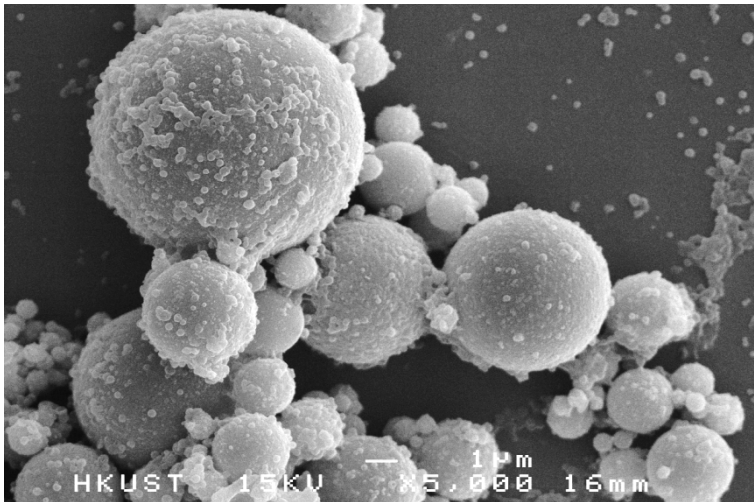
# Surface Morphology



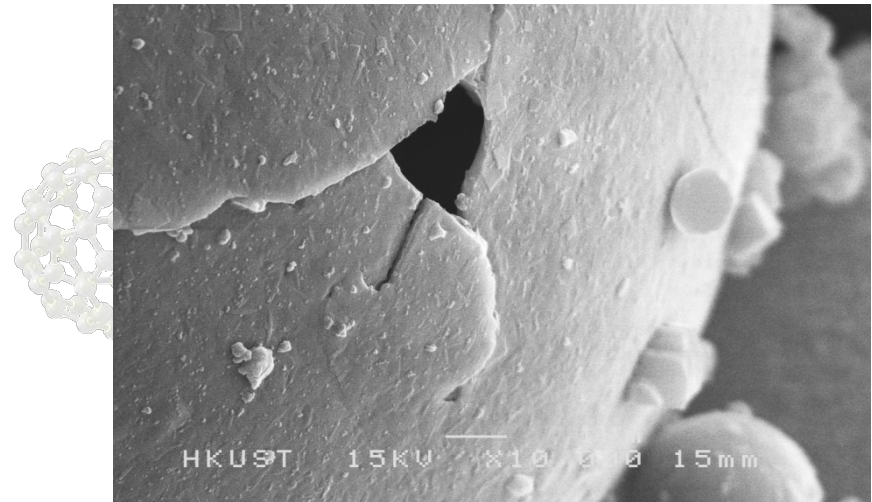
Ordinary Portland Cement



Ground granulated blast-furnace slag



A cluster of fly ash

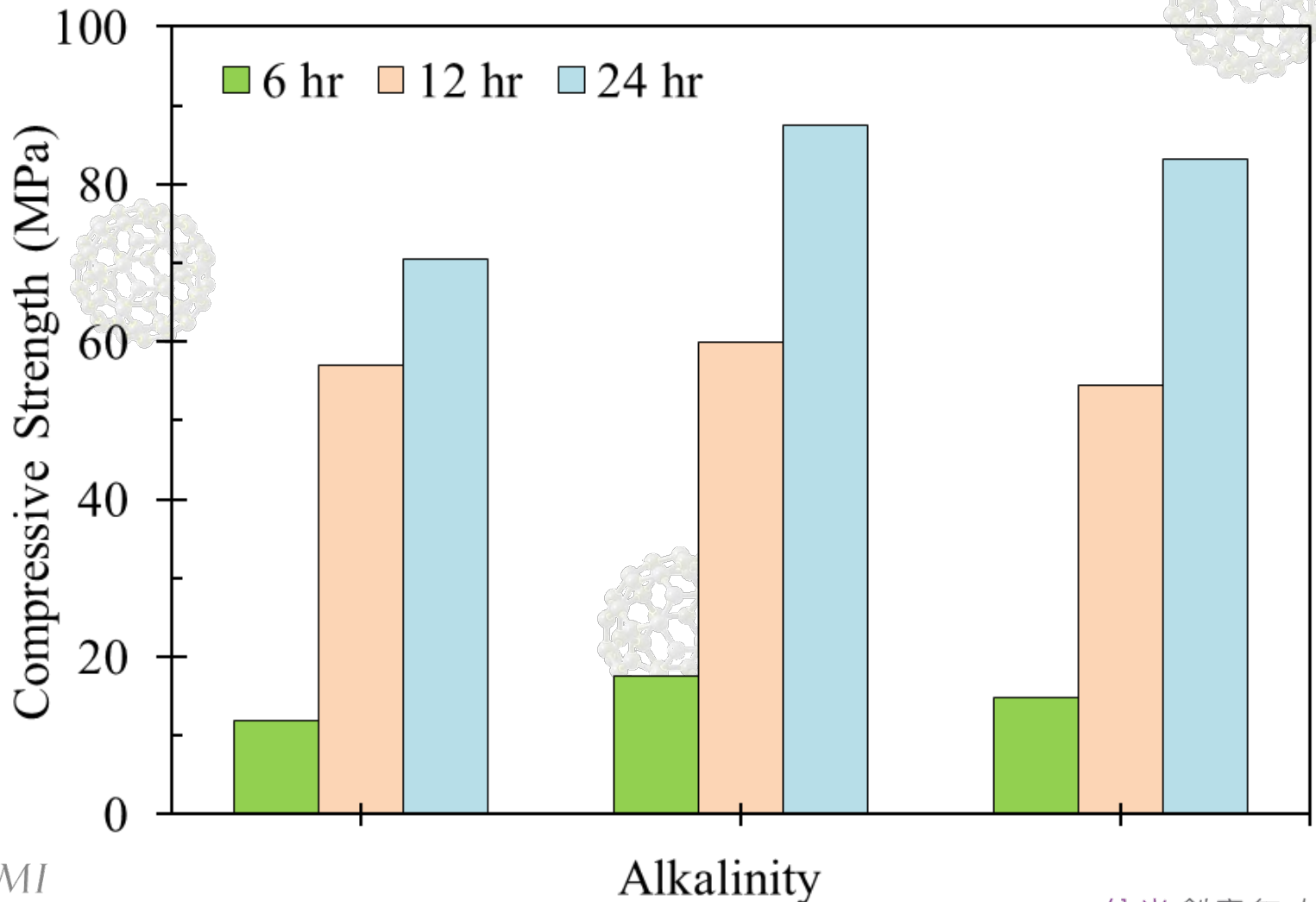


The spherical shell structure



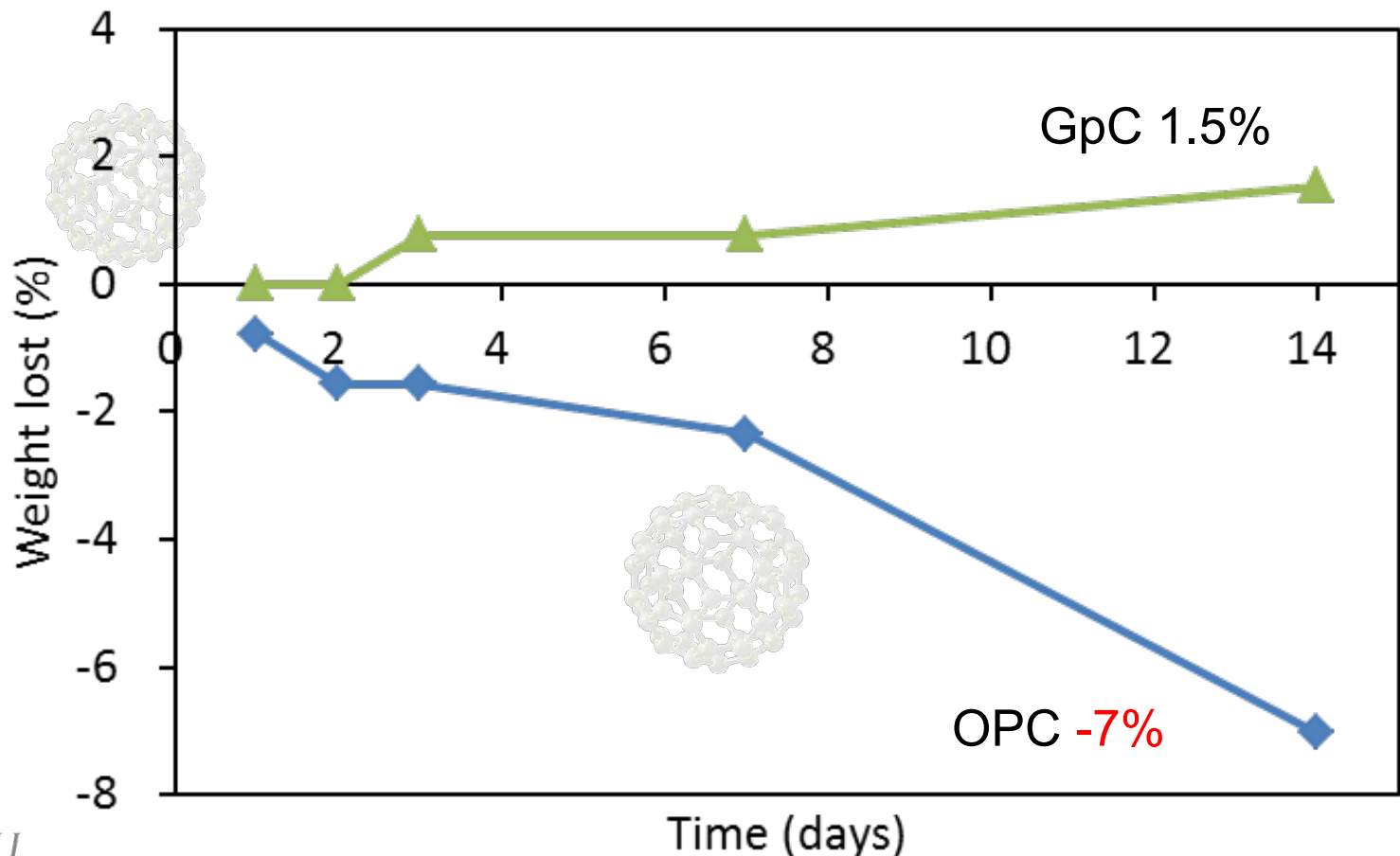
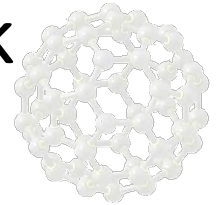
# Early Strength for Rapid Repair

- Facility can be re-open within several hours



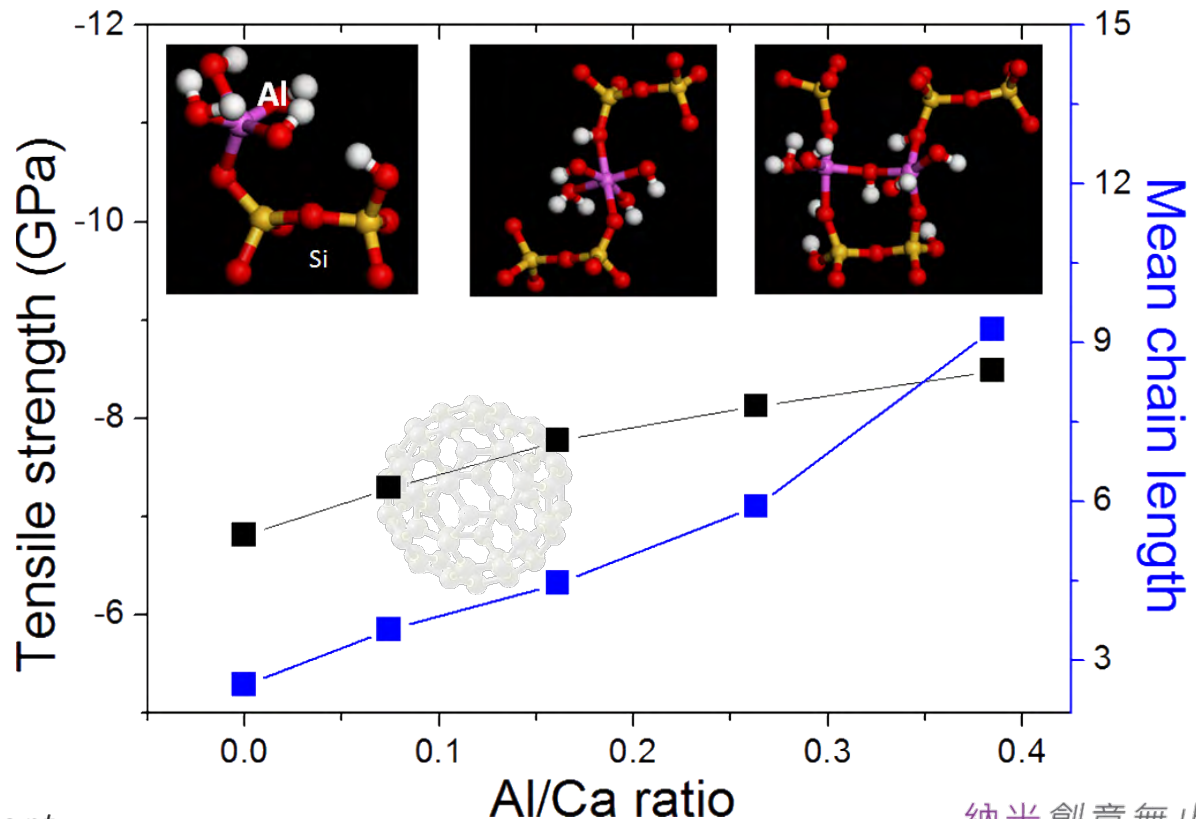
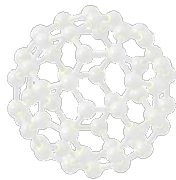
# Acid Resistance of GpC

- Residual strength after 14-day acid attack
  - GpC (54 MPa) / cement paste (39 MPa)

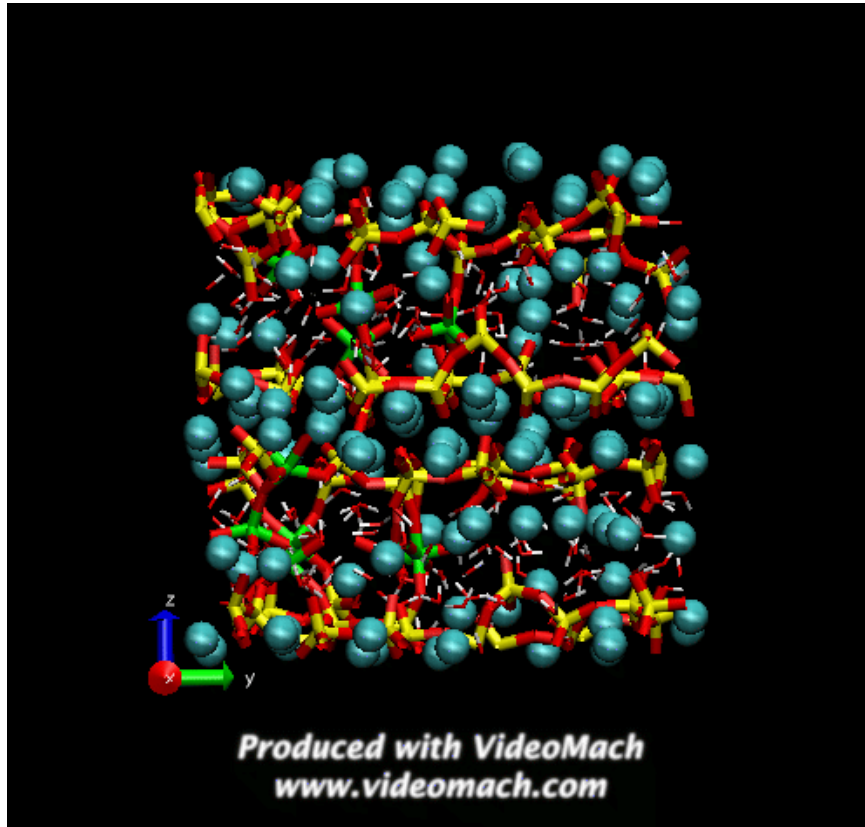


# The C-A-S-H gel

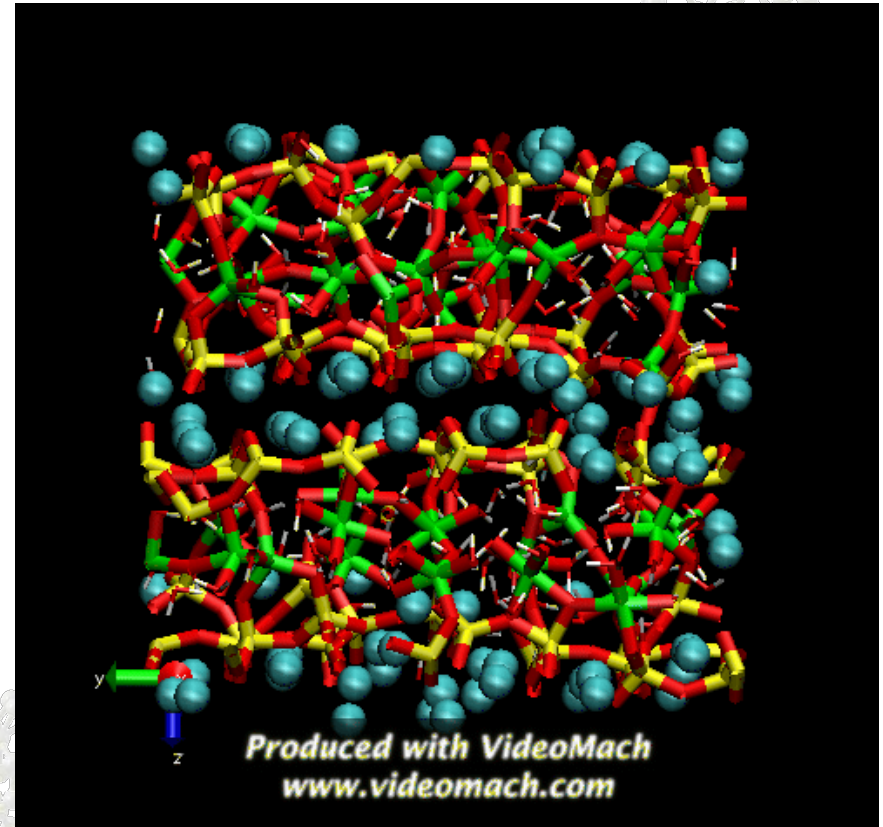
- Aluminate species **strengthened** silicate chains & transform layered structure to **3-D network**
- Enhancing the stiffness of C-S-H gel



# Strengthened Interlayer Region



Al/Ca=0.08



Al/Ca=0.38

# Concluding Remarks

- Contributing to the sustainable development geopolymerisation is a **green technology**
- Utilizing metakaolin, slag & fly ash, geopolymer is a prominent **alternative cement**
- Demonstrating the capability of **early strength development & excellent chemical resistance**
- Geopolymer based material **can be customized** for different applications



# Ongoing Research Works

- Characterizing functional **admixtures** for & **optimization** of GpM for different applications
- Identifying **long term & stable supply** of quality raw materials
- Commercialization & **promotion** of geopolymer based materials in HK
- **Collaborations** with universities/ institutes and industries are welcome
- **Graduates** with related background are strongly **welcome to join us**





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Thank You Very Much!

Let's unleash world-class technologies to benefit your growth.