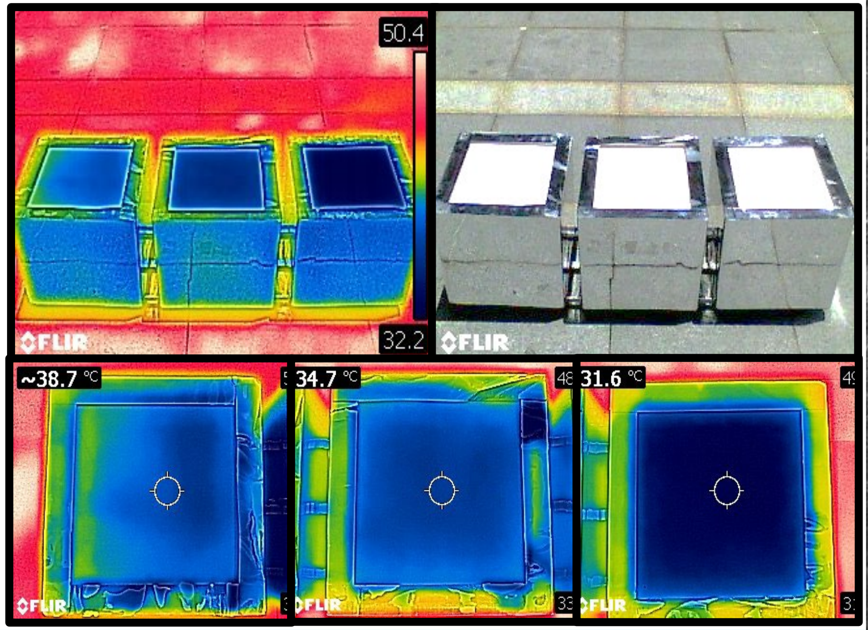
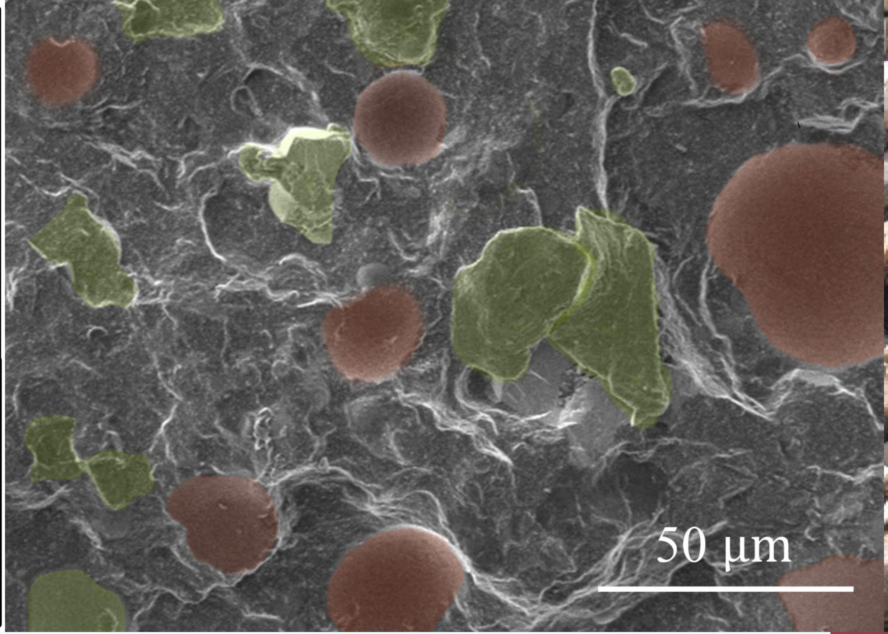




THE HONG KONG POLYTECHNIC UNIVERSITY
香港理工大學

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING
土木及環境工程學系

Functional Construction Materials Laboratory

ZN1101, Block Z,

Department of Civil and Environmental Engineering,

The Hong Kong Polytechnic University

Opening Minds • Shaping the Future
啟迪思維・成就未來

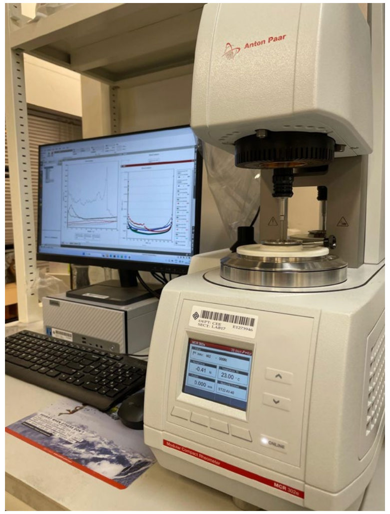
Introduction

This laboratory focuses on functional construction materials' researches.

<u>For Advanced Research</u>

> Anton Paar MCR 302e Modular Compact Rheometer
> Mettler Toledo G400 ParticleTrack
> Mettler Toledo G20S Compact Potentiometric Titrator
> Carbolite VMF10/6 Volatile Matter Furnace
> Carbolite CTF12/65/550 Tube Furnace
> Mettler Toledo G20S Compact Potentiometric Titrator
> Metrohm Multi Autolab/M204 - Multi Potentiostat/Galvanostat
> SHEL LAB CO2 Incubator
> IKA Overhead Stirrers RW 20 digital
> Plasma Enhanced Chemical Vapor Deposition System

Main Equipment



Anton Paar MCR 302e
Modular Compact Rheometer

MCR 302e allows quick and easy rheological measurements with torque range from 0.5 nNm to 230 mNm.

It has active thermal management of motor and bearing for long-term measurements even at high torques.

Mettler Toledo G400
ParticleTrack

This probe-based instrument with Focused Beam Reflectance Measurement, FRRM, technology is inserted into laboratory reactors to track changes of particle size and count in real time at full process concentrations. It helps to determine the influence of process parameters on particle size and count.

Mettler Toledo G20S
Compact Potentiometric Titrator

G20S extends usability with the same space saving design as the Compact titrators. It supports 150 analysis methods with 12 method functions + 12 shortcuts per user, plus LabX Express software for multiple routine titrations and users.

Main Equipment

Carbolite VMF10/6
Volatile Matter Furnace

This volatile matter furnace fulfills the requirements of ISO 562:2010. It has working volume capacity of 100 x 210 x 260mm and working temperature up to 1000 degree Celsius.

Carbolite CTF12/65/550
Tube Furnace

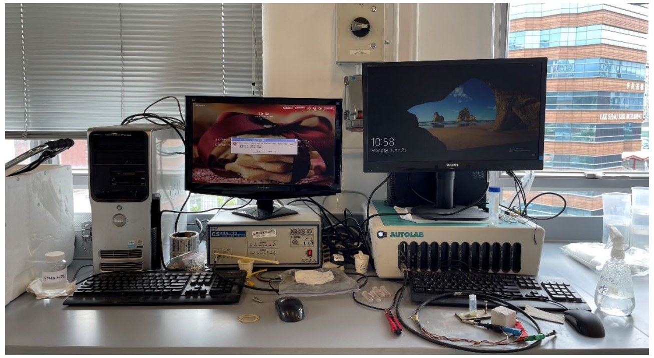
This furnace's work tubes protect the furnace construction from contaminants and make it easier to maintain a modified atmosphere around the samples. It is more suitable for processing smaller samples due to its smaller volume capacity and fast heat-up rates.

It has 1200 deg Celsius as its max work temperature when the ceramic work tube is wound with resistance wire.

Ametek VersaSCAN
Electrochemical Scanning System

This system is capable of providing spatial resolution to both electrochemical and materials-based measurements. It integrates a positioning system, measurement instrumentation and probe to provide local information of anodic or cathodic character.

Main Equipment



Metrohm Multi Autolab/M204 – Multi Potentiostat/Galvanostat

This is a multi channel potentiostat/ galvanostat based on the compact Autolab PGSTAT204. It consists of a Multi Autolab Cabinet which can be fitted with up to 12 M204 modules.

Each M204 is a completely independent potentiostat/ galvanostat, which allows users to perform different measurements on each channel at the same time.

SHEL LAB CO2 Incubator

This CO2 Incubator serves a wide range of bacterial and cell growth applications using innovative technology to ensure uniform temperature and humidity levels within small error margins.

IKA Overhead Stirrers RW 20 digital

The overhead stirrers are capable for universal use from 60 to 2000rpm speed. They can stir samples quantities of up to 20L H_2O.

Main Equipment

Plasma Enhanced Chemical Vapor Deposition System

The plasma enhance chemical vapor deposition (PECVD) system is designed for two-dimensional nanomaterials synthesis such as the graphene and carbon nanotube (CNT).

The system includes a high-temperature tube furnace with the temperature up to 1400 Celsius, four mass flow controllers for gas delivery, liquid nitrogen cold trap for moisture elimination, air bubbler for liquid phase precursor delivery and a plasma source for pretreatment of the gas precursor to achieve lower reaction temperature. The system is capable of graphene, CNT, MoS2, and other 2D nanomaterials synthesis.

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Research Spotlight

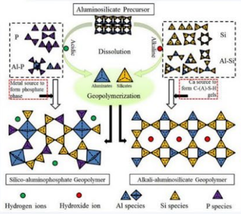
Low-carbon Geopolymer Cementitious Composites

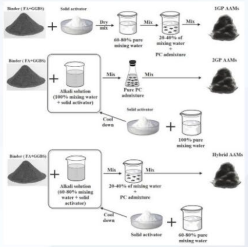
Low-carbon Geopolymer Cementitious Composites

- Global warming and climate change are huge concerns worldwide. Hong Kong has promised to achieve carbon neutrality before 2050. Since the cement industry is one of the major contributors to global warming, clinker-free cement, which is also referred to as geopolymer or alkali-activated material (AAM), is one of possible solutions to lower greenhouse gas emissions and help to achieve carbon neutrality.
- Production of geopolymer concrete can lead to a reduction of CO_2 emissions by 50%-80% and require 60% less energy compared with that of conventional ordinary Portland cement (OPC) concrete.
- Geopolymer is manufactured through chemical activation of aluminosilicate precursor materials, either naturally available such as metakaolin or from industrial byproducts like fly ash or slag (termed as "precursor"), using acidic or alkaline agents (labeled as "activator").

Terminology and mixing approaches

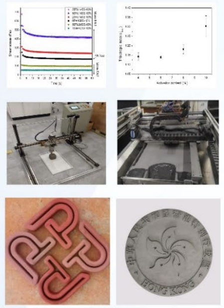
- Alkali-aluminosilicate geopolymers or silico-aluminophosphate geopolymers based on the activation process of aluminosilicate sources under alkaline or acidic conditions.
- C-(A)-S-H gels and/or N-A-S-H gels are dominant in alkali-aluminosilicate geopolymers.
- S-A-P gels dominate silico-aluminophosphate geopolymers.
- Production of geopolymer can be achieved following either "one-part" terminology (solid activators) or "two-part" system (liquid activators).
- The one-part or "just-add-water" geopolymer has excellent potential in practice due to its simple operation (simply mixing water with the readily-mixed binder).
- The one-part geopolymer can be produced as distributive bagged material, enabling convenient storage, safe transportation, and mass production.
- The technology of superplasticizers is still under development.





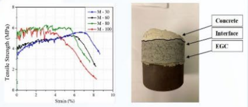
Additive manufacturing (3D printing)

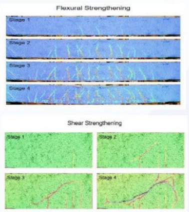
- Rheology and thixotropy of one-part geopolymer are the controlling factors.
- The 3D printing in construction is usually carried out by means of an automated, selective, and layer-by-layer deposition of cement-based materials through extrusion or powder-bed/inkjet technology, which may be a potential game-changer in the construction industry.
- Successful 3D printing examples of one-part geopolymer using extrusion and powder-bed/inkjet technologies.



Repair material

- Using the one-part geopolymer cement, high-performance mortars can be achieved and implemented as repair materials.
- By the addition of fiber reinforcement, super ductile engineered geopolymer composites (EGC) can be developed.
- Geopolymer mortar possesses excellent bond strength with OPC concrete and can be used for rehabilitation and strengthening.





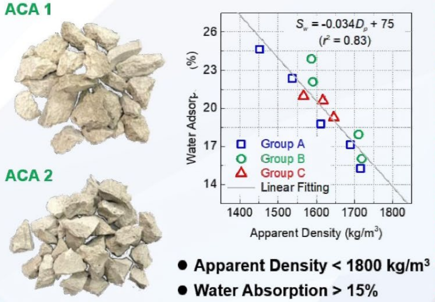
Functional Artificial Aggregates for Sustainable Construction

Functional Artificial Aggregates for Sustainable Construction

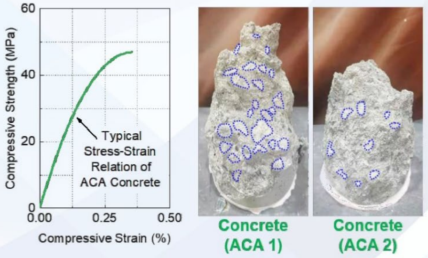
Aggregates occupy most volume of concrete materials. Shortages of natural aggregates (sand and gravel) nowadays become a critical problem for concrete industry because of the unprecedented scale of construction activities. The large-scale excavation of natural aggregates has also severely imposed a threat onto natural environments.

Artificial aggregates can be produced from industry by-products/urban wastes that increase annually through the sintering or cold bonding technology. Manufacturing artificial aggregates provides a one-stone two-birds solution to the above-mentioned problem. Cost-effective methods are being explored here to produce both coarse and fine artificial aggregates with large-quantity, which can be also functionized with different physical, mechanical and chemical properties during the manufacturing, to enable production of high-performance cement & concrete composites.

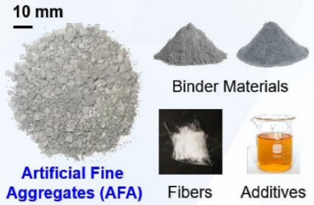
Artificial Coarse Aggregates (ACA) for Ordinary Concrete



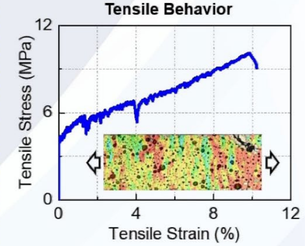
- Apparent Density < 1800 kg/m³
- Water Absorption > 15%



Artificial Fine Aggregates (AFA) for High-Performance Cementitious Composites

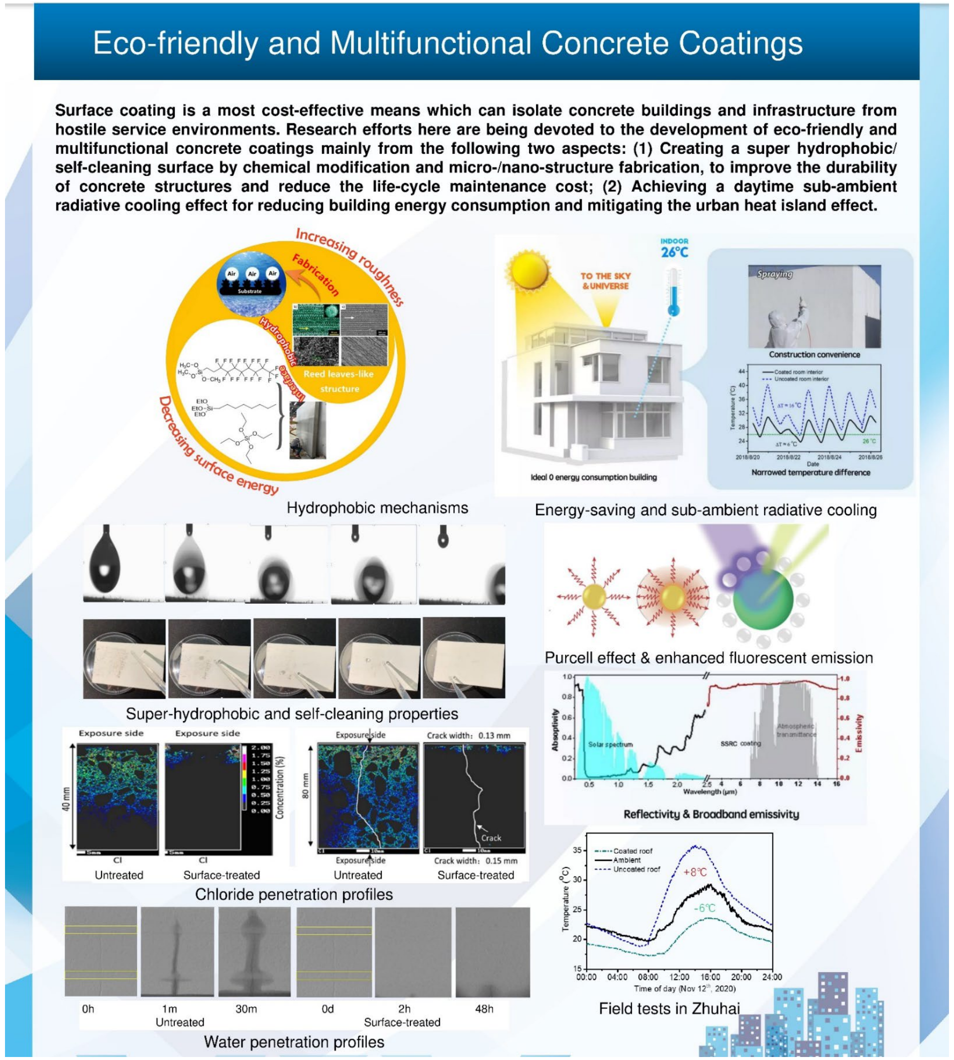


High-Performance Fiber-Reinforced Cementitious Composites with AFA

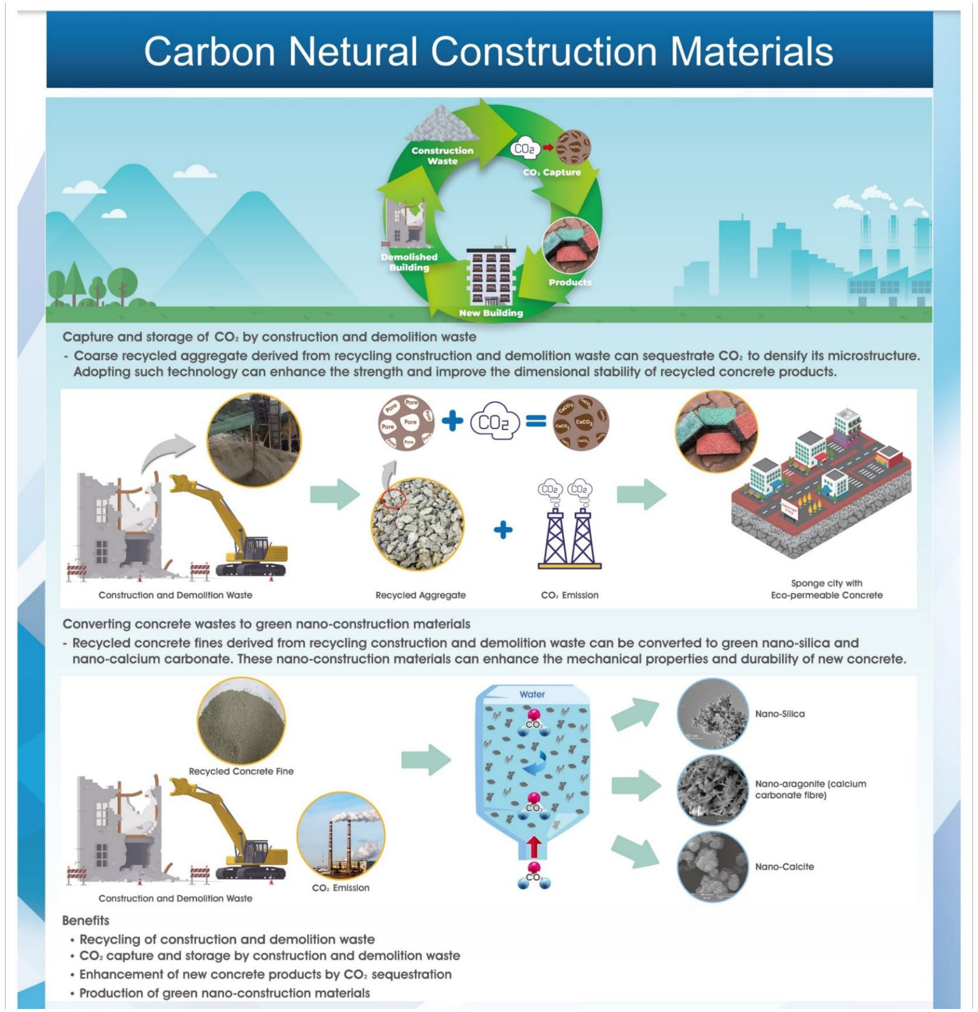


Research Spotlight

Eco-friendly and Multifunctional Concrete Coatings



Carbon Neutral Construction Materials



Lab-in-charge and Technical Staff

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(excluding Saturday, Sunday & public holidays)