

Welcome to the Newsletter e-Science Putra. This issue presents the research activities from May to August 2024 which highlight the latest research findings by the selected faculty members.

HIGHLIGHTS

- Artscience as a Gamechanger to Increase Interest in STEM
- Hidden In Plain Sight: The Enigmatic Blooms of Leafless Orchid – *Erythrorchis Altissima*
- From Waste to Wealth: Sustainable Innovations in Dental Glass-Ceramics
- Innovative Catalytic Approach for Benzyl Alcohol Oxidation Using Pd-Pt/rGO Nanocatalysts

ARTSCIENCE AS A GAMECHANGER TO INCREASE INTEREST IN STEM



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There is a worrying trend of reducing number of secondary school students choosing STEM subjects. In 2020 the Ministry of Education reported that only 47.18 % of students in school were engaged in STEM activities. Only 20.51 % chose pure science subjects, while the remaining 26.67 % took technical education and vocational training (TVET) subjects (Idris et al. 2023). The reasons for this decline are the students find STEM subjects hard to understand and the preference for non-STEM subjects. How can we scientists encourage the school children to be interested in learning STEM courses? Science can be taught in alternative ways i.e. Artscience.

Presenting the scientific data via artworks can help to overcome the fatigue of the doom-and-gloom state of the planet. It is time that more effective communication between STEM (Science, Technology, Engineering, Mathematics) and HASS (Humanities, Arts, Social Sciences) be cultivated at academic levels. Under eDU-PARK@UPM the NYAWA® (Nature's Yield and Wonders of Art) exhibition was held annually from 2012-2019. It showcases the research using artistic format that was shown in Galeri Serdang, Faculty of Design and Architecture. The process brought both scientists and non-scientists researchers together that in turn brings more appreciation and understanding of each other's fields (Nasir et al. 2018). This practice was continued with NYAWA®@Madison where Aquascape was created using cyanotype. Cyanotype is a 200-year-old photography method created by Herschel. Aquascape highlighted the dangers of invasive aquatic plant species. The most recent artsience artifact entitled Zoollery Art Intervention:BLUE was created in collaboration with Professor Jennifer Angus of University of Wisconsin, Madison, USA and Dr Noor Azrizal Abdul Wahid, UPM. An art intervention is a new work that interacts with an existing exhibit or display causing it to be seen in a fresh way, seeing what might seem ordinary as extraordinary.

Cyanotype was used for the background of 15 cabinets of curiosities and for decorative purposes at the Malaysian Open House. There are also insect jellies made with natural colorants (Roselle/ *Hibiscus sabdarifa*, Green tea/ *Camellia sinensis*, Lavender/ *Lavandula angustifolia*, Rosehip/ *Rosa* spp., Turmeric/ *Curcuma longa*, Butterfly pea flower/ *Clitoria ternea*).

Visitors especially schoolchildren are invited to visit as they can admire the art design as well as learn about the extensive animal specimens. The cyanotype method has been incorporated in the assignment for BGY 3201 Structure and Function of Plants where the students present plant morphology artistically. The next step is to introduce cyanotype at lower secondary schools to gauge the gamechanging impact of artsience in raising the interest in STEM subjects.

The Zoollery, Biology Department is open to the public weekdays by appointment. Contact no 0132808480



Figure 1. Aquascape is a compilation of cyanotypes of native and invasive plant species. This artwork highlights the danger of introducing non-indigenous species to a new habitat.



Figure 2. The Malaysian Open House with Rusa jawa/Javan deer/*Rusa timorens*, Penyau hijau/Green sea turtle/*Chelonia mydas*, Kera ekor panjang/Long-tailed macaque/*Macaca fascicularis*, Tenggiling/Pangolin/*Manis javanica*, Burung hantu kuang/Oriental Scops Owl/*Otus sunia*, Musang pulut/Common palm civet/*Paradoxurus musangus*

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HIDDEN IN PLAIN SIGHT: THE ENIGMATIC BLOOMS OF LEAFLESS ORCHID – ERYTHROCHIS ALTISSIMA



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Erythrorchis, commonly known as bootlace orchids, is a genus comprising two accepted species (POWO, 2024) that defy conventional plant characteristics. During an expedition to the coastal heath forest of Hutan Simpan Berserah, Pahang, we encountered one such species, *Erythrorchis altissima* (Blume) Blume. At first glance, it appeared to be nothing more than a lifeless, tangled vine blending into the surrounding decaying wood (Figure 1). However, this leafless, chlorophyll-free vine, with its reddish-brown branching stem that is often curved and covered in scales is far from ordinary. When this elusive plant bursts into bloom, it unveils its true identity as one of the most fascinating orchids in existence. This species produces numerous pale yellow flowers that open successively and is capable of growing up to 10 meters in length (Figure 2). Its survival is equally remarkable as it relies entirely through a parasitic relationship with fungi—a strategy known as mycoheterotrophy. In the dense, humid, and shaded areas of the forest, *E. altissima* draws all its nutrients from the fungi it parasitizes, showcasing a remarkable adaptation that allows it to thrive without photosynthesis. Notably, Tsujita et al. (2017) discovered that this orchid associates with at least 37 different fungal species, most of which are responsible for breaking down organic matter in the forest. This intricate symbiosis enables *E. altissima* to access a vast reservoir of carbon and nutrients, allowing it to produce numerous flowers despite its unconventional lifestyle.

The conservation of *E. altissima* is crucial despite its current listing as Least Concern (LC) on the IUCN Red List, last assessed in 2010. This orchid's survival depends on preserving its specialized habitat that supports the specific mycorrhizae vital to its mycoheterotrophic lifestyle. Although its conservation status may not indicate immediate risk, *E. altissima* faces significant threats from habitat degradation due to human interference and urban development—factors that are rapidly eroding the forest areas essential for many vulnerable mycoheterotrophic species. Additionally, climate change poses a significant risk by potentially disrupting the delicate environmental conditions necessary for its survival. Given the ongoing loss of forest areas and the potential vulnerability of many mycoheterotrophic plants, including those with limited distribution and small population sizes, the need for habitat conservation is more urgent than ever (Merckx et al., 2013). Protecting the habitats where *E. altissima* and other mycoheterotrophic species thrive is not just crucial—it is our only effective strategy for ensuring their continued survival. We must act now to preserve these delicate ecosystems before it is too late, ensuring that these phenomenal plants continue to grace our Earth for generations to come.



Figure 1. The lifeless, tangled vine of *Erythrorchis altissima* in the natural habitat. Photos: Rusea Go



Figure 2. The numerous pale yellow flowers that open successively of the most fascinating leafless orchid in existence. Photos: Rusea Go

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FROM WASTE TO WEALTH: SUSTAINABLE INNOVATIONS IN DENTAL GLASS-CERAMICS



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As the global population ages, bones and teeth in adults and even children become increasingly vulnerable to fractures due to the gradual decline in mechanical strength over time. The challenge is to replace the fractured area with a material that can retain the same properties as the host materials before they become defective. Biomaterials, such as bioactive glass, glass-ceramics, and hydroxyapatite, have proven crucial in addressing this challenge. These materials are engineered to interact with the human body and act as an excellent alternative to conventional materials in many biomedical and dental applications.

In the studies by Loh et al. (2022), the bioactive glass-ceramics were synthesized using waste eggshells as a calcium source. This innovative approach was designed to enhance the mechanical properties of the material, making it suitable for dental applications. Figure 1 illustrates the hardness and toughness value of human enamel. To achieve optimal mechanical properties, the bioactive glass was heat-treated at various temperatures. Generally, tooth structures are built to withstand repeated cycles of masticatory forces, often exceeding 700N.

The results revealed that glass-ceramics treated at 700°C (Figure 2) exhibited the highest hardness value of 6.72 GPa and fracture toughness of 3.55 MPa·m^{1/2}. These values are comparable to human enamel, which typically has a hardness range of 2.00 GPa – 5.00 GPa and toughness of 0.60 MPa·m^{1/2} – 3.93 MPa·m^{1/2}. These findings highlight the potential of a low-cost, waste-derived bioactive glass-ceramics system, paving the way for sustainable advancements in dental applications.

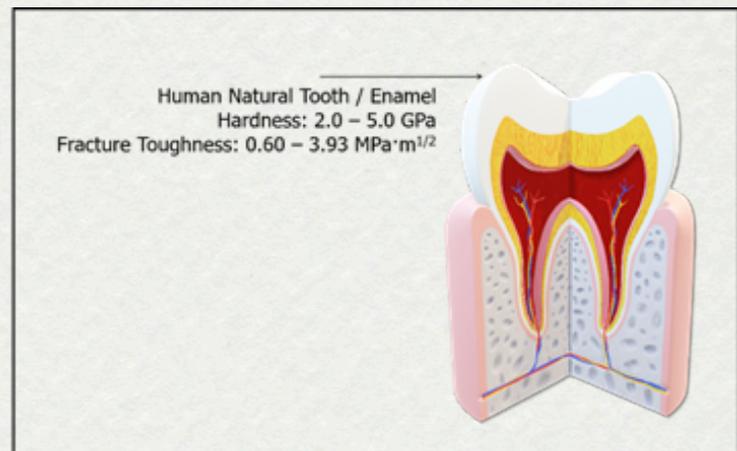


Figure 1. The hardness and toughness value of a normal human enamel

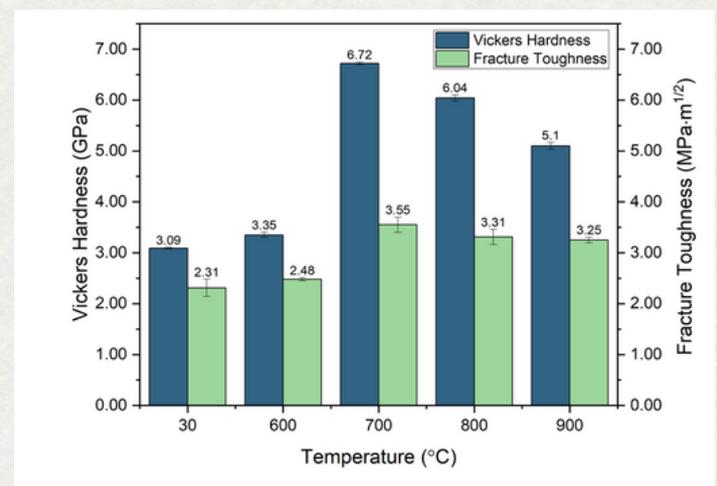


Figure 2. Vickers microhardness and fracture toughness of the samples heat-treated at different temperatures.

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INNOVATIVE CATALYTIC APPROACH FOR BENZYL ALCOHOL OXIDATION USING Pd-Pt/RGO NANOCATALYSTS



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Selective oxidation of benzyl alcohol is a critical process in creating intermediates and final products for chemical, pharmaceutical, and agricultural industries. Addressing the challenges of catalytic efficiency, researchers have developed a novel Pd-Pt/rGO bimetallic catalyst. Synthesized using a sol-immobilization method, this catalyst involves the deposition of palladium and platinum nanoparticles on reduced graphene oxide (rGO), prepared via a microwave-assisted technique. The graphene oxide (GO) precursor was obtained using the modified Hummer's method.

For comparison, monometallic Pd/rGO and Pt/rGO catalysts were also synthesized using the same approach. These catalysts underwent extensive characterization through advanced techniques such as XRD, TGA, FTIR, XRF, TPD-CO₂, and SEM-EDX. Performance testing was conducted in benzyl alcohol oxidation using O₂ as the oxidant at 70°C under moderate conditions. Gas Chromatography-Flame Ionization Detection (GC-FID) analysis revealed that the Pd-Pt/rGO catalyst outperformed its monometallic counterparts, achieving a benzyl alcohol conversion rate of 6.3% with selective production of toluene, benzaldehyde, and benzoic acid.

Prolonged reaction times of 8 and 24 hours demonstrated further improvements, increasing the conversion rate to 8.0%. This study underscores the potential of Pd-Pt/rGO catalysts as highly selective and efficient solutions for benzyl alcohol oxidation under environmentally friendly conditions.

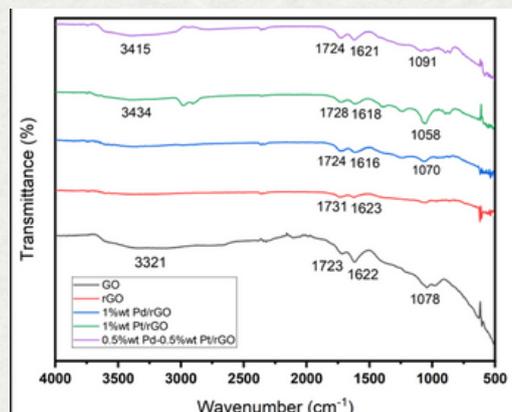
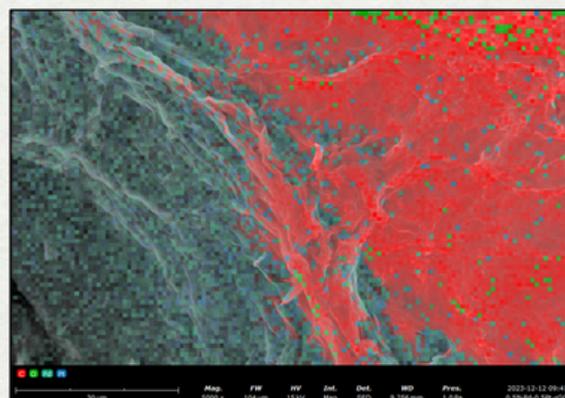


Figure 1: The successful reduction process of GO to rGO based on the reduced intensity of O-H (~3321cm⁻¹) and C=O (~1723cm⁻¹) peaks.



0.5wt% Pd - 0.5wt% Pt/rGO	Element Name	Weight Conc.
C	Carbon	60.400
O	Oxygen	39.000
Pd	Palladium	0.400
Pt	Platinum	0.200

Figure 2: The even dispersion of Pd and Pt metal on the surface of the rGO

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**Science is much more than just a body of KNOWLEDGE.
It is a way of THINKING.**

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