Moulding the future of 21st-century materials

The open design of the new Innovative Composite Center at the Kanazawa Institute of Technology facilitates the exchange of ideas and materials — without the technology needed to process composites being locked away. The ICC provides professional education encompassing a wide range of activities through its massive, open prototyping area, which is designed to promote communication between researchers. The openness and transparency, the lab and analysis zones surrounding the prototyping area are transparent, making work visible and easier to share. "One of the themes of ICC is to develop markets for composite materials in offshore structures and infrastructure fields," remarks Uzawa. “This requires large machines for moulding and testing. Luckily, in the centre of the ICC, however, is its massive, open prototyping area, which can be viewed from every floor of the facility." "One of the themes of ICC is to develop markets for composite materials in offshore structures and infrastructure fields," remarks Uzawa. “This requires large machines for moulding and testing. Luckily, in the centre of the ICC, however, is its massive, open prototyping area, which can be viewed from every floor of the facility.”

Fibre fundamentals
Carbon fibres are usually produced by heating spun polycrylonitrile, a polymer similar to those used in acryl clothing and carpets, into long strips thinner than human hair. Heat treatment expels nitrogen and hydrogen from the precursors, leaving an extended fibre composed of fused, graphite-like carbon rings. The fibres are used to reinforce plastic resins, similar to how steel bars reinforce concrete. The chemical structure of carbon fibres imparts the material with extraordinary strength — more than five times that of steel — while remaining lightweight. These desirable properties have led to it being widely used in the aerospace and automotive industries as well as in consumer goods such as sporting gear. But the complex machinery needed to spin, manipulate and heat process carbon fibres makes them significantly more expensive than metals. Because of this high cost, carbon fibres have found limited application and, hence their fabrication technology remains immature and their manufacturing cost high. “In the past, the high cost of carbon-fibre composites limited their applications,” says Uzawa. “No one seriously thought they could be a substitute for iron or concrete in practical structures.”

Putting vision into practice
Japan is a world leader in the carbon-fibre market, with its top three players accounting for two-thirds of global production. The ICC has a mission to open new markets for these unique materials and expand the use of composite materials in various fields by promoting the application technology development. To accomplish this, the institute was constructed to promote partnerships between universities and companies from the ground up. The striking three-floor facility features an accessible work environment: doors and walls are minimized in large, integrated workspaces. Hallways are spacious and designed to promote communication between researchers. Plentiful windows bring in natural light and encourage passersby to look in on their colleagues’ work. The centrepiece of the ICC, however, is its massive, open prototyping area, which can be viewed from every floor of the facility. “One of the themes of ICC is to develop markets for composite materials in offshore structures and infrastructure fields.”

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The design of the Kanazawa Institute of Technology includes a different strategy. “ICC is working on a production technology using ‘stampable’ sheets — intermediate materials of thermoplastic resin-impregnated carbon-fibre sheet that can be moulded under pressure.” The temperature-saving process makes composites moulding significantly more economical. Revising up for mass production
There is a need to establish mass-production systems for composite materials, to make them competitive in the automobile industry, among others. Meeting this demand is the goal of ICC’s third project. It seeks to achieve a ‘by-product’ moulding technology by the resin transfer moulding process. In this approach, thermoset and carbon-fibre composites can be fabricated in mass as well as in prototype quantities, with the accompanying polymer resins being set to play an important role in expanding the possibilities of composite materials. But collaborations between resin researchers and industrial engineers to search for promising polymers are quite rare. “The ICC is the first domestic composite-materials research organization adopting a full-scale approach, which includes research and development," says Uzawa. “One area we focus on, in collaboration with Kanazawa University, is using biomaterials for composites. Increasingly, researchers are examining renewable substances, such as wood-based biomass, as raw chemical sources instead of petroleum products. In conventional biofilling, tough molecules such as lignin and cellulose, broken down into smaller glucose rings, which can then be polymerized into resins. The ICC adopts a different strategy. ‘ICC is working on a production technology using ‘stampable’ sheets — intermediate materials of thermoplastic resin-impregnated carbon-fibre sheet that can be moulded under pressure.’ The time-saving process makes composites moulding significantly more economical.

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