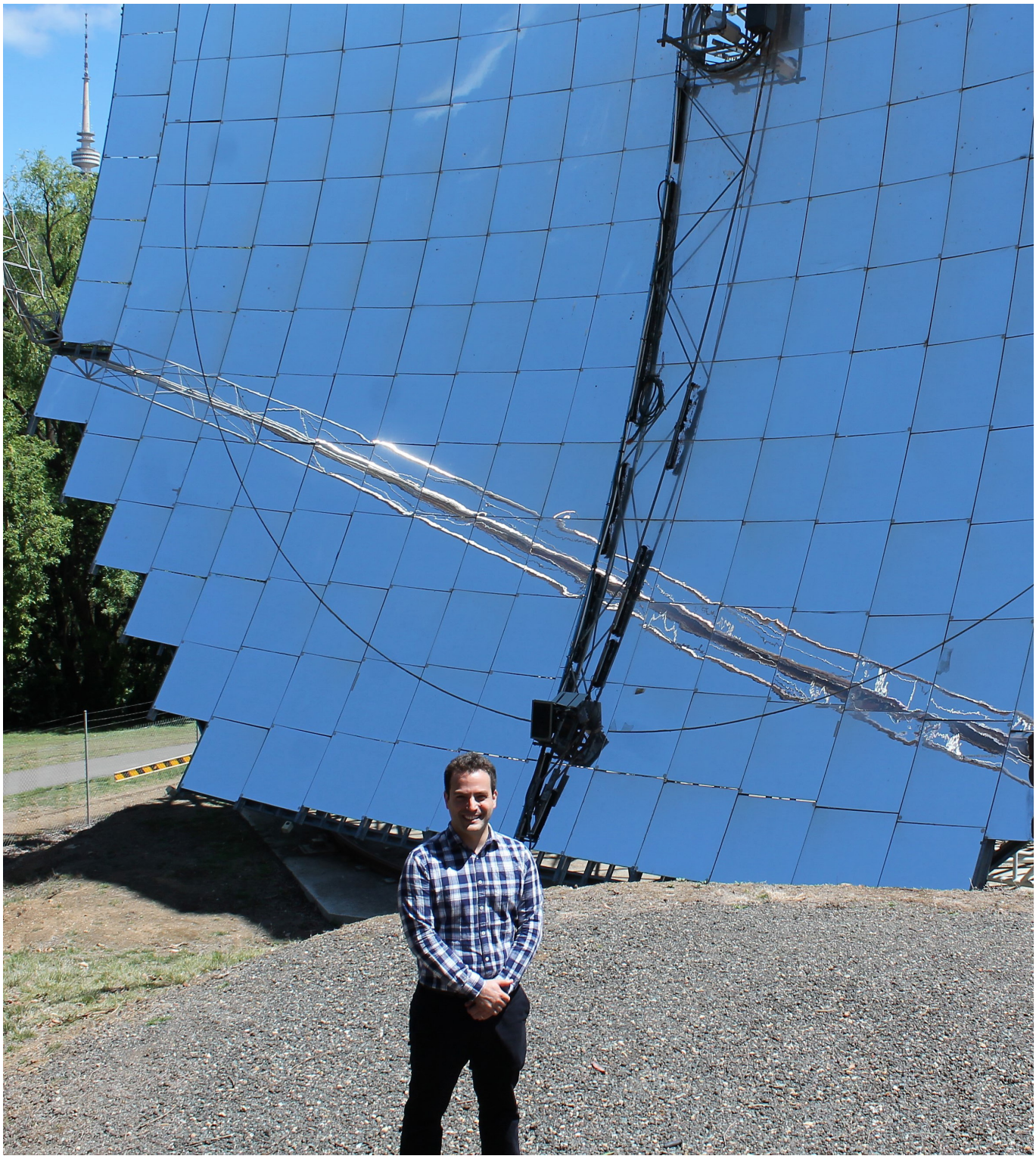


Felipe in front of the big dish at The Australian National University. Photo courtesy of the author.

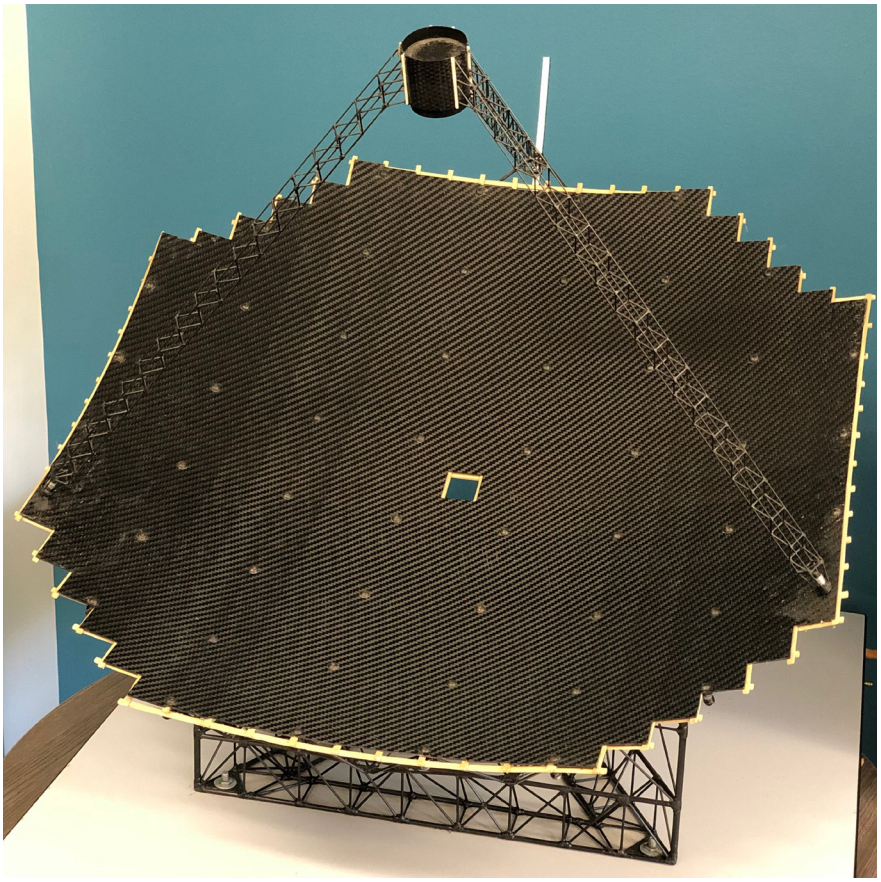
SOLAR ORIGAMI

Juan Felipe Torres

Solar-thermal energy is an expanding form of renewable energy. It is another way of extracting energy from the sun. . .

I have an ongoing, deep connection with Japan. I lived in Japan for twelve years and I am currently collaborating with Japanese industry partners and universities. I first went to Japan on a *Monbukagakusho* scholarship, funded by the Japanese Government. This gave me the opportunity to learn Japanese and study science and technology in Japan. After completing language training in Tokyo, I moved to the Department of Engineering at Tohoku University. I was there for a total of eight years, completing my undergraduate, master and PhD degrees. After graduating from my PhD, I worked at Toshiba Corporation as a research scientist for two and a half years, before joining The Australian National University.

In 2016, I began to work on solar-thermal power in Australia. My project uses mirrors to focus sunlight at a particular spot where a dark-coloured receiver absorbs the light. The focused solar energy is then turned into heat which we use to produce electricity. Solar-thermal energy is an expanding form of renewable energy. It is another way of extracting energy from the sun, similar to photovoltaics, which are used in solar panels. Solar-thermal energy has a major advantage over photovoltaics because the solar-energy conversion occurs in the whole solar spectrum and energy storage technology is very cheap, as heat is much easier to store than electricity.



A model of the big dish shown at the OBJECTively symposium, 2019.
Photo courtesy of the author.

My object is a big dish held at The Australian National University. It is 500-square metres wide and the symbol of the Solar Thermal Group. The mirrors all reflect the light of the sun and focus it at one point, from which the receiver absorbs the heat. This receiver has a black coating on it that helps it to trap the light. It is this black coating that I am working on.

My project has been developed in connection with industry contacts in Japan. Together we have coating that is better than state-of-the-art. These coatings will be used in solar thermal projects similar to that of this dish.

This black coating traps almost ninety-seven per cent of the sunlight, is long-lasting and can withstand extremely high temperatures of up to 900 degrees Celsius. What we are doing is changing the morphology of the coating to create multiple reflections and improve the amount of light that is trapped. This process resembles origami in the sense that the morphology of state-of-the-art coatings, which is generally flat, is being modified into porous-like morphologies to promote multiple reflections and light trapping. That is, the flatness is changed to enhance the function. In origami this is done to enhance the beauty of an object whereas

here it is done to enhance light absorption. We can deposit this absorber coating on a very strong nickel-based alloy called Inconel, which is used on jet engines.

Along with my Japanese partners, I am changing the morphology of the coating on the nano- and micro- scales in order to create a coral-like structure within the black coating. We are modelling these structures on naturally occurring coral patterns, as coral also needs to capture a lot of sunlight to survive. This aims to help solve a bottleneck problem with the current coating by improving the durability of the coating and the amount of light it traps. We also use different length scales in the coating as we are trying to capture light of different wavelengths.

The main aim is to improve energy conversion from solar to thermal. With this technology we can help create new, efficient renewable energies, as well as new fuels to use in vehicles such as electric cars and jet engines. This is critical given the reality of global warming. Currently, a company in South Australia is using this system to utilise the energy of the sun in a desalination plant and to grow tomatoes in the desert. We can also use this energy with some form of biomass to create liquid fuels and hydrogen. Japan is investing heavily in hydrogen at the moment as a new potential fuel source. Through our collaboration, Japan and Australia are exploring ways to better harness the sun to improve our everyday lives and benefit our shared planet.

Juan Felipe Torres obtained a double-degree PhD in 2014 in Mechanical Engineering from Ecole Centrale de Lyon, France, and Tohoku University, Japan, where he lived for more than twelve years. He moved to Japan in 2004 from his native Colombia with a distinguished scholarship from the Japanese government. After his studies, Torres worked at Toshiba Research & Development Center for two and a half years and then moved to Australia in late 2016 to pursue an academic career at the ANU College of Engineering & Computer Science. His research interests are in sustainable technologies based on heat and mass transfer processes.