Development of Heat Reflective Glazing on Plastic Windows for Electric Vehicles

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The company

The Future Industries Institute (FII) was established by the University of South Australia (UniSA) in 2015, in partnership with University College London (UCL). FII works to develop new technologies and materials for industrial application. Made up of around 30 researchers, PhD students and interns, the Thin Film Coatings Group develops coatings ranging from a few nanometres to a few microns in thickness.

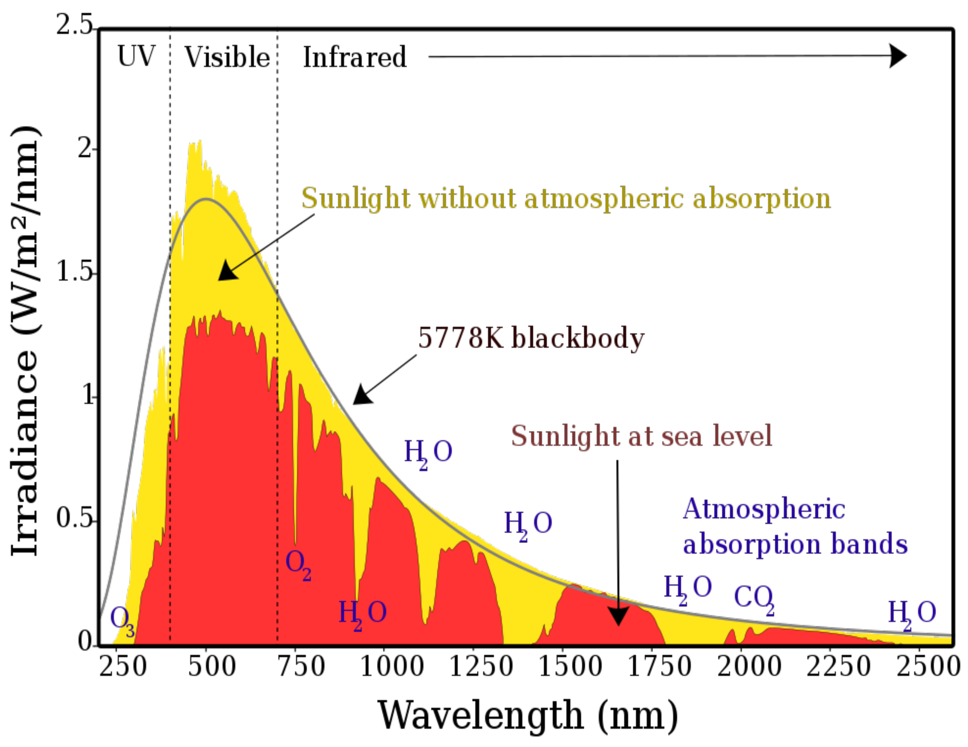

Figure 1. Solar radiation spectrum above the atmosphere and at sea level, and the blackbody spectrum

The project

My project aims to improve the efficiency of electric cars by replacing heavy glass windows with polycarbonate to reduce their weight, and applying a heat reflective coating to these windows to reduce the need for air conditioning. Since A/C uses a lot of energy to cool the cabin, reducing the amount of solar heat entering the car will increase the distance the car can travel on a single charge.

The coating reflects as much IR radiation as possible without reducing the visible transmittance, so the windows are still transparent. It is based on a metal layer, responsible for reflecting solar IR radiation, sandwiched between two transparent layers which enhance the transmittance in the visible range.

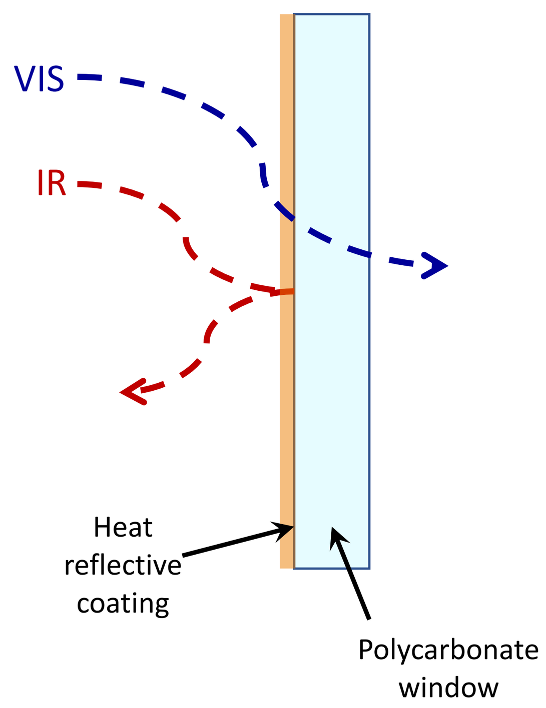

Figure 2. A diagram showing how light interacts with the heat reflective window

My role

While the basic structure of the coating had been thought out, the specific materials had not been decided, nor the thickness of each layer. I used computer simulation software to compare the optical properties of different metals and transparent materials. The most promising combinations of materials and thicknesses were deposited onto polycarbonate substrates by a process called sputter deposition.

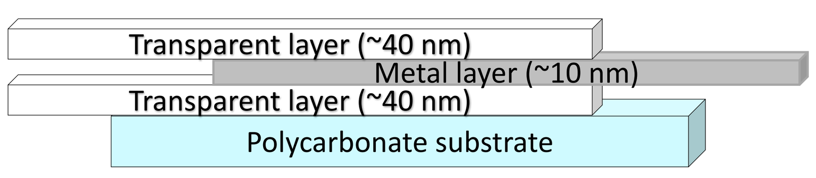

Figure 3. Overview of the structure of the coating

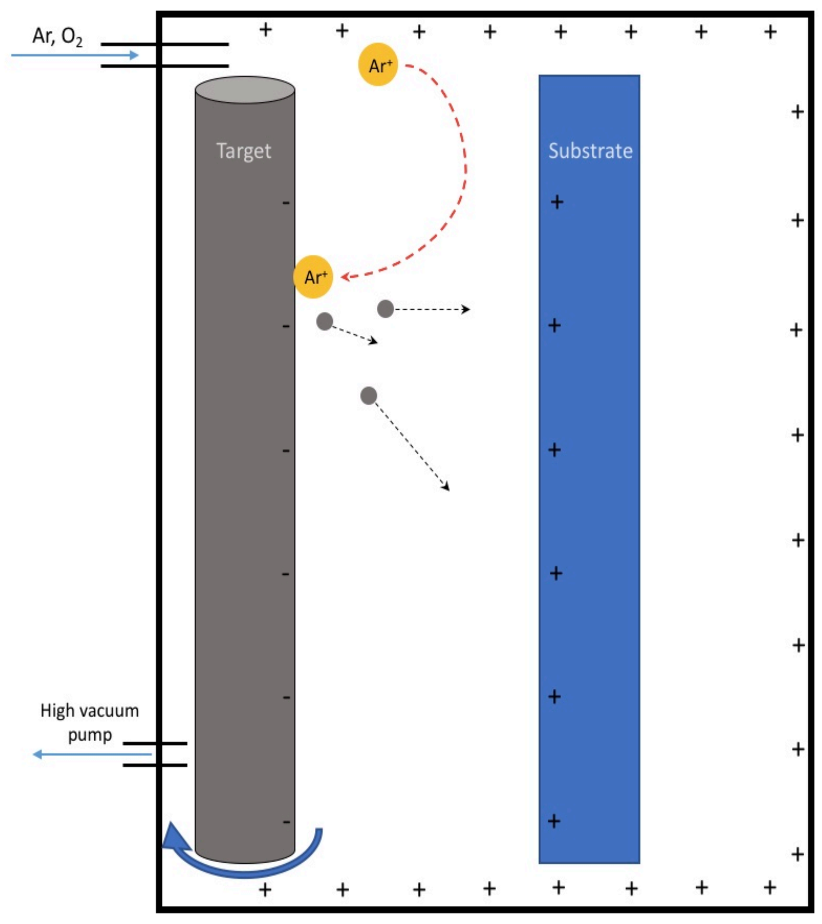

Figure 4. Schematic of sputter deposition

Sample analysis

Once the films had been deposited, a transmittance spectrum of each sample was obtained using a Cary Spectrophotometer. A series of samples were made with SiO_2 as the transparent layers and Cu as the metal layer. Each sample had a different Cu layer thickness and their transmittance spectra are shown below.

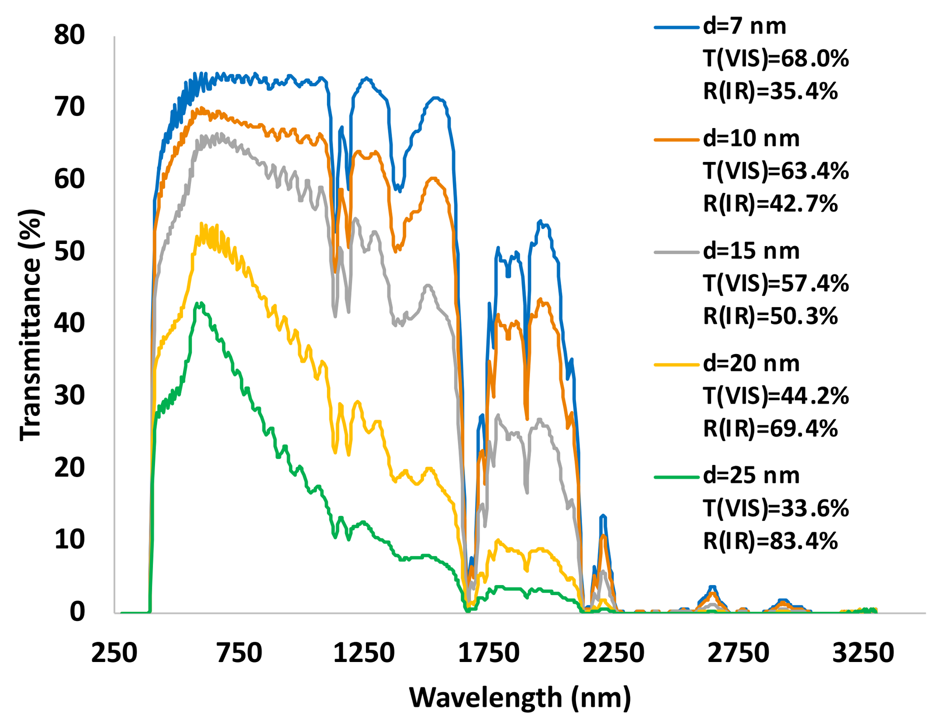

Figure 5. Transmittance spectra of coatings with Cu layer thickness 7, 10, 15, 20, 25 nm.

Durability tests

Since these coatings are designed to go on the outside of the windows, they need to be durable and resistant to corrosion. A big part of my project involved carrying out standard adhesion and abrasion tests on the samples I made, as well as testing their resistance to salt spray fog. We found that none of the coatings were resistant to corrosion by salt spray, so we decided to apply a hard coat to the samples.

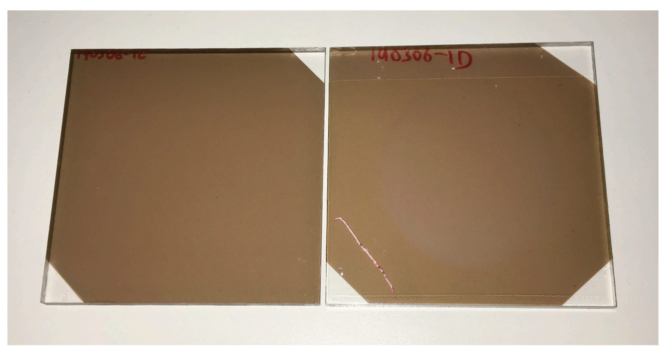

Figure 6. SiO_2/Cu samples before and after abrasion test

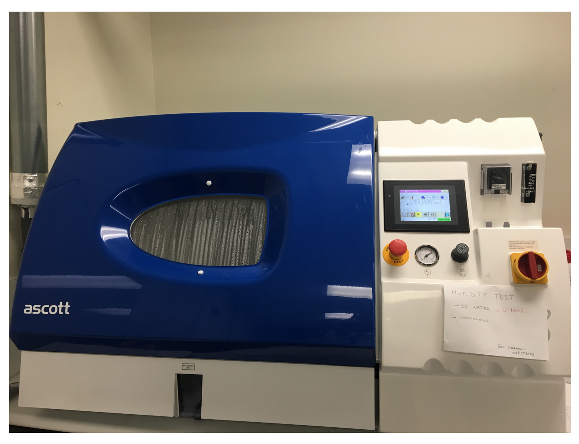

Figure 7. Salt spray chamber used to test corrosion resistance

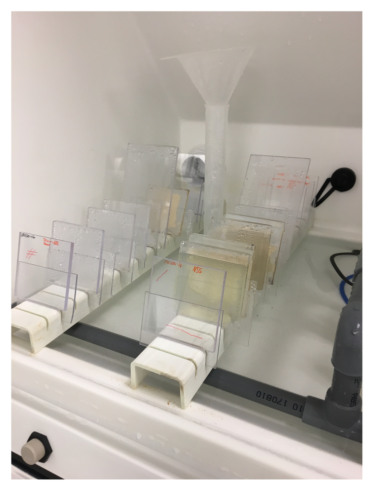

Figure 8. Samples inside chamber

Conclusion and final product

The final structure of the heat reflective coating is shown below, along with its transmittance spectrum before and after the hard coat was applied. Values for visible transmittance (%T(VIS)) and blocked infrared (%B(IR)) are also shown.

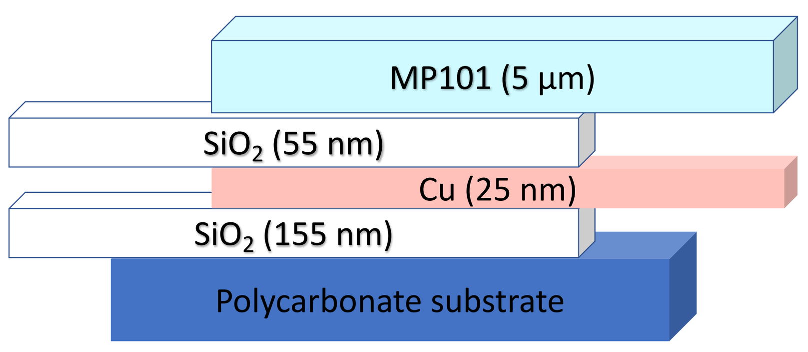

Figure 9. Structure of final coating

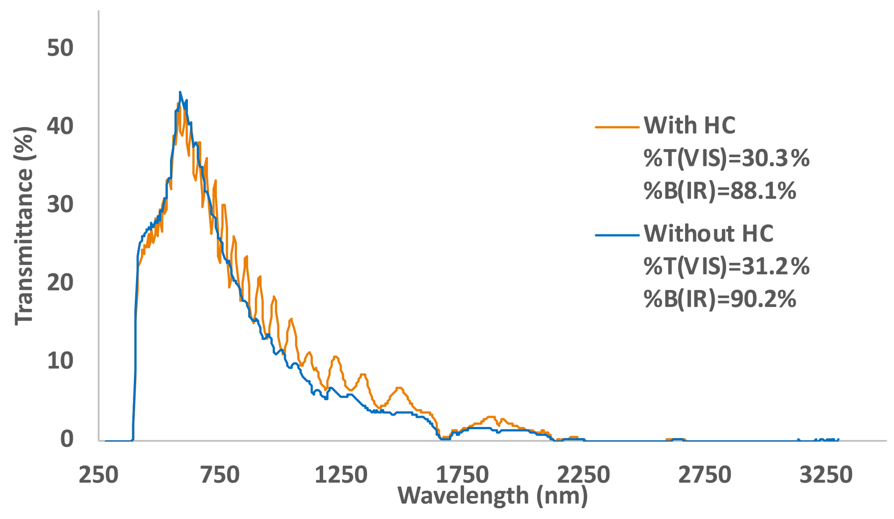

Figure 10. Transmittance spectra of final coating before and after application of MP101 hardcoat

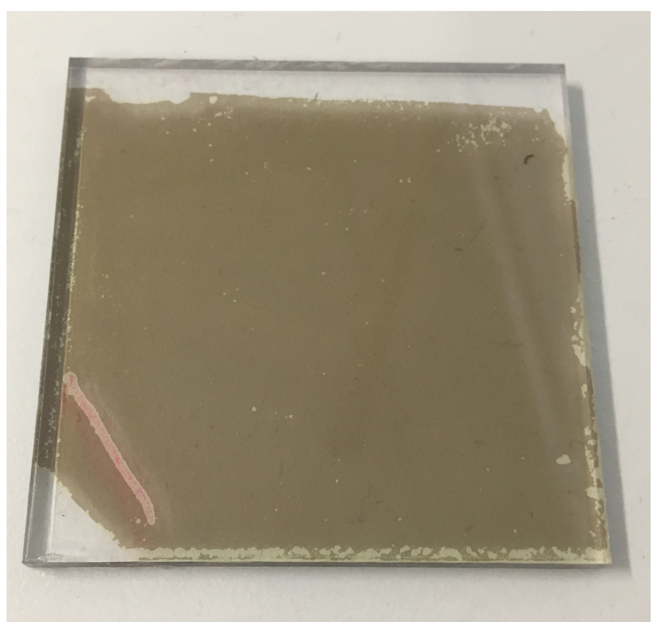

Figure 11. Final coating on a 7x7 cm sample of polycarbonate after 42 days in salt spray chamber with majority of coating intact

Extra details about this placement

- Large proportion of the 30 people in the group were undergraduate or PhD students and they are a sociable group.
- I got a generous amount of holiday time and was encouraged by my supervisors to take the opportunity to travel around Australia.