

China International Science Linkages (ISL) Project

The aim of this project is to develop a novel solar concentrator receiver in which silicon solar cells are immersed in heat transfer fluid, allowing improved conversion efficiency and manufacturability.

This collaborative research project is as a natural extension of a comprehensive collaboration with Tianjin University in China in the field of solar linear concentrators. The existing cooperation between TJU and ANU is supported by the Asia Pacific Partnership program.

The ISL project titled “Efficient power/thermal co-generation from linearly concentrated sunlight by liquid-immersed solar cells” will benefit from this collaboration, and will allow a new strategic direction by developing novel liquid immersed receivers.

More about this project

Direct immersion of the solar cells in the cooling fluid eliminates the 10-15° rise in cell temperature.

Linear concentrators, in which the receiver lies at the focal line of a long, single-axis sun-tracking system with reflective or refractive optics, typically operate with concentrations in the range 15-50 times normal solar intensity. In this range, silicon solar cells have an advantage over alternative solar cells in terms of high electrical conversion efficiency (~20%) and modest cost (10-40 cents per sq. cm).

Cell cooling is required. This can be passive (heat fins) or active (cooling fluid). Active cooling is attractive for several reasons, including that use can be made of the 80% of the absorbed solar energy that is converted to heat rather than electricity. This heat can be delivered to a thermal load at temperatures in the range 70-120°, allowing uses such as hot water, space heating and space cooling. The combined electrical and thermal solar conversion efficiency could exceed 70%.

Solar cells are usually bonded to a concentrator receiver using thermally conductive but electrically insulating bonding structures. Significant improvements would be possible if the cells could be directly immersed in the cooling fluid within the receiver, including elimination of the detrimental rise in cell temperature attributable to thermal resistance of the bonding structures and elimination of thermal expansion mismatch stress between the cells and the metal receiver.

Both Universities have extensive prior experience with linear concentrator systems. The extensive existing facilities at TJU & ANU will be utilized, including linear concentrator systems and 20% efficient mono-crystalline silicon concentrator solar cells developed by ANU (including silver cells).

ANU will be generally responsible for cell selection and cell assembly, while TJU will be responsible for cooling fluid chemistry and thermodynamics. Both Universities will participate in optical investigations and the extensive accelerated lifetime and outdoors testing that will be undertaken throughout the project.