Degradation mechanisms and sustainability in state-of-the-art Silicon photovoltaic cell manufacture.

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Silicon photovoltaics are now by far the cheapest form of electricity generation for locations within 45° of the equator. This is based on levelized costs and assuming a 20 year cell life. The IEA (International Energy Authority) calculate that Silicon PV will be the largest contributor to World electricity generation by 2027. More significantly it is predicted that the installed capacity of photovoltaics will increase from the current 1TW to 50TW by 2050. Although silicon is one of the most abundant elements on earth this presents enormous challenges for manufacturing and supply chains. Currently 90% of new capacity is based on Silicon PERC (*Passivated Emitter and Rear Contact*) cell technology invented at the University of New South Wales in the 1980s. Better and cheaper designs are at an advanced stage of development and will displace PERC in the next decade. However all have basic problems in relation to sustainability. Two key issues need to be addressed. Firstly efficiency is reduced over the 20 year operating life by poorly understood degradation mechanisms. Secondly the use non-earth abundant elements have to be answered. Silver is used to make contact to the silicon via a printing and heat treatment method. In order to manufacture 50TW of cells using known technologies more than twice the world's know reserves of silver would be required.

The speaker will outline recent work in the photon science, quantum materials and devices group at Manchester on degradation mechanisms in the current generation of silicon PV technologies. He will discuss the properties of the Boron-Oxygen defect centre they have proposed to behind the BOLID degradation mechanism that degrades cell performance shortly after exposure to sunlight, this defect causes the loss of the energy equivalent of Mts of carbon per annum. He will move on to their recent work on the properties of Hydrogen on Silicon Cells and its potential as an origin of light enhance thermal induced degradation (LETID) in similar cells. This mechanism is not understood but under certain conditions can degrade a cells performance by as much as 20%.

Finally the issues of recycling cells will be discussed in the light of a life exceeding 20 years and rapid expansion. We conclude that the use of earth rare Silver for contacting is not sustainable and a major research effort to find alternatives is essential if the world's PV targets are to be achieved.

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