**Ever since Charles Fritts coated the semi-conductor selenium with a thin layer of gold to make the first solid state photovoltaic cell way back in eighteen seventy nine, science bods all over the world have been developing the process to make it more efficient, more practical and less expensive. Modern panels are about twenty times as efficient as those first prototypes, and recent mass production, mostly in China, has brought prices down to extremely competitive levels. Solar PV panels are perfect for rooftops and ground mounted arrays, and of course they’re already playing a major role in the transition away from fossil fuels towards more sustainable electricity grids.**

**But there are millions of surfaces in our modern world that are not quite so conveniently flat, and many of them also get exposed to sunlight every day. No doubt you’ve heard the statistics about the mind-blowing amount of sunlight that reaches our planet, but it doesn’t hurt to remind ourselves every now and then that the amount of power from the sun striking the Earth in one single hour is more than the entire world consumes in a whole year.**

**Unsurprisingly then, a whole sphere of research has grown up to find ways to build solar PV technology into thinner and more flexible materials that might be able to take advantage of all those currently underutilised and awkardly shaped surfaces.**

**Thin film cells have been used in things like solar powered calculators since the nineteen seventies. Nowadays we’re starting to see flexible panels appearing on some electric vehicles, and in a few very sophisticated building integrated systems. But it’s still far from mainstream, and that’s a shame because if someone can really nail it then flexible thin film photovoltaics could be mopping up the sun’s energy all over the place, providing immediate localised energy to drive our modern technologies with zero carbon emissions at the point of use.**

**Well, now, a UK company called Power Roll reckon they’ve come up with a revolutionary new way of fabricating highly efficient, flexible photovoltaic rolls that could just fit that bill perfectly.**

**Hello and welcome to Just Have a Think**

**Power Roll are a specialist materials architecture company based in County Durham up in the North-East of England.**

**They’ve teamed up with a physicist and inventor by the name of John Topping who has extensive expertise in the production of vacuum coated materials used in the food packaging industry. You know, things like those snack wrappers with metalized internal surfaces.**

**Apparently, John had a bit of an epiphany moment a few years back when he realised that it might be possible to combine those very inexpensive roll-to-roll vacuum coating systems with the latest micro-scale printing and embossing technologies to come up with a process that could manufacture solar photovoltaic films at the same speed and with the same mass production economies of scale as food wrappers.**

**I caught up with the Chief Executive of Power Roll, Neil Spann, via Zoom a few weeks ago, to learn more about how the process works.**

**A typical solar panel is made up of a transparent conductive oxide, or TCO, layer on top of a semi-conductor - typically silicon. The top section of silicon is infused, or ‘doped’, with another element like phosphorous, and the bottom section is doped with something like boron. When photons hit the silicon layer, they knock electrons free and, for reasons that are outside the scope of this video, the two doped materials act like electrodes on either side of a battery and facilitate the movement of those electrons out of the photovoltaic sandwich and into an electrical circuit.**

**We looked at exactly what causes this to happen in an earlier video about Perovskite solar panels, so if you’re keen to get the detail then you can click the link up there to jump back to that one.**

**The Power Roll system effectively turns that sandwich arrangement on its side. The starting point is a pretty standard polymer substrate, like PET, into which tiny microstructures are embossed, creating V-shaped channels or grooves in the material that are no more than one or two microns thick. That’s about one 50th of the width of an average human hair, and about a fifth the width of a human blood cell.**

**A ten by ten centimetre square can contain seventeen thousand of these channels running parallel to each other across the width of the panel.**

**A vacuum coating system applies the electrodes and electron transfer layers equivalent to the horizontal layers in a standard silicon cell, effectively creating negative and positive electrodes. Power Roll has developed a unique proprietary technique to ensure an even coating and to make sure that the two materials can’t come into contact with each other at the base of the groove. Because that would cause a short circuit. Which you don’t want!**

**Then, a solar absorbing ink is printed into the middle part of the groove. That arrangement does away with the need for the expensive TCO layer. Light just comes straight in, hits the ink and contacts with the electrodes on either side.**

**There’s a single volt of potential difference in each groove, based on the current solar ink that Power Roll is using, and the architecture of the construction means the grooves are physically connected together in series. In other words, negative to positive. You may remember from school physics lessons that connecting batteries in series adds up their voltages. That means a piece of material that’s only ten centimetres wide can have a potential difference across it of seventeen thousand volts.**

**Now, sticking seventeen thousand volt materials onto the sides of bus shelters and letter boxes is probably not a great idea, so the next step in the Power Roll process is to physically separate the channels into microscopic modules, or cascades as their known, using a second microgroove feature. It’s a patented technique that Power Roll call delineation.**

**The grooves can be split into as many or as few cascades as necessary, depending on the voltage required by a given application.**

**So, for example, by splitting seventeen thousand grooves into three hundred and forty cascades, each cascade will have a potential difference of fifty volts.**

**Which sounds a bit less ‘fatal’ doesn’t it?**

**The separated cascades are then connected back up in parallel, which keeps the voltage the same but increases the current. That means the size of the current is derived not just from the length of each conductive groove but also by how many parallel connected cascades there are on the panel.**

**Another crucial proprietary element of the process is a technology that ensures extreme accuracy in the separation between the cascades, again eliminating the risk of unwanted cross communication.**

**The panel gets a final protection coating and that’s it. Done. All that’s required now is for wires to be attached to either side to produce an electrical circuit, and of course some photons from sunshine to start knocking those electrons out of their comfort zone.**

**One of the beauties of this configuration is that if one cascade is in shade or gets damaged, it doesn’t affect the other cascades either side of it. They just keep on generating regardless. You could literally nail one of these things to a wooden post and it would keep working, although that’s obviously not going to be the recommended installation procedure! Instead, a highly adhesive backing film will be supplied to do the job.**

**According to the folks at Power Roll, their process is completely unique and extremely inexpensive, because it’s based on the smart combination of already existing technologies.**

**The embossing technology is the same as the systems used to create the little holograms on your credit and debit cards. The vacuum coating technology comes straight from the food packaging industry. And the ink printing technology is well established in many different sectors.**

**Working out how to combine all three together effectively has taken a great deal of development work though, and the Power Roll process is now patented in seventy countries around the world.**

**Full scale production films will be produced in widths of either thirty, fifty or one hundred centimetres, and a typical panel will be up to ten metres in length.**

**The business model here is not to directly compete with existing rigid solar PV panels. The efficiency of the Power Roll film is currently about eleven percent with a development path towards sixteen percent. The main goal is really to drive down the cost of production and provide a solution that can easily be replicated anywhere in the world, energising previously inaccessible surfaces to produce very useful local electricity.**

**Power Roll have been working with test houses in the US and Europe including the American National Renewable Energy Lab, or NREL. Test data suggest that a roll of film light enough for an average person to carry in their arms would have a generating capacity of twenty kilowatts. That opens up all sorts of applications that are only really limited by the imagination, not just in industrialised countries, but in developing nations as well. In remote off grid locations, they could become a very inexpensive and portable carbon free replacement for diesel generators and kerosine lamps. They’d also be a perfect fit for tensile structures like the roof of The Millennium Dome in London for example or, perhaps more usefully, on tents in the refugee camps that are sadly becoming more and more common place as climate change and regional conflicts continue to flare up around the world.**

**The production of the film itself, does of course have a carbon footprint, mainly in the PET material used as the substrate, but there are no high temperatures involved in any of the steps and overall, it’s a high speed, low energy process. Compared to traditional rigid silicon PV panels it only has about one twentieth of the carbon impact.**

**The levelized cost of electricity has also been analysed and assessed to be forty five percent lower than rigid PV panels, which translates into about half the payback time of a traditional Solar PV installation.**

**The next step for Power Roll is full testing to achieve global industry accreditation. One of the results of that testing will be a certified operational lifetime, but Power Roll’s own fairly rigorous internal tests have shown this to be a very robust product with a projected lifetime of between ten and fifteen years.**

**Power Roll will maintain a production and research & development facility in the UK and then licence the technology to manufacturing partners around the world. Partnering with companies in other territories is a smart strategic move. It accelerates the speed of global distribution and utilises local expertise to reach otherwise inaccessible markets. It also affords some protection against patent infringement and counterfeiting, which will almost certainly become a challenge as the technology gains in popularity.**

**The UK pilot plant will be finalised in 2021, with larger volume production and commercial licensing commencing in 2022, and mass production in multiple geographic locations during 2023.**

**As we transition to a more sustainable future, we’ll need every viable renewable technology available over the coming decades. Decentralised distributed power sources like this one will play a big role in that effort and they have huge potential to transform lives all over the world.**

**As always, if you’ve got experience in this industry, or views about this technology one way or the other, then why not jump down to the comments section below and leave your thoughts there.**

**That’s it for this week though.**

**I’m having a snoop around the COP 26 climate conference up in Glasgow for the next few days so there’ll be no video next weekend. But I’ll be back with another dive into the world of climate change and sustainable energy on Sunday the fourteenth of November. In the meantime, thanks for watching, and I must just give a quick shout out to the folks who’ve just started supporting the channel over at Patreon with pledges of ten dollars or more a month.**

**They are**

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**Ian Nash**

**Paul Doucette**

**Michiel Dethmers**

**And**

**Tony Troughton-Smith**

**And of course a big thank you to everyone else who’s joined since last time too.**

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**and you can hugely support the channel completely free by hitting that subscribe button which you can do very easily by clicking down there or on that icon there.**

**So, thanks again for watching. Have a great couple of weeks and remember to just have a think. See you soon.**