

SolarWhite: A coating that allows spacecraft to get close to the sun

Associate Professor Kenneth Stanton
School of Mechanical and Materials Engineering



ACADEMIC



CULTURAL



ECONOMIC



SCIENTIFIC



TECHNOLOGICAL



TRAINING

SUMMARY

UCD researchers have developed a special white coating, SolarWhite, to enable spacecraft to travel into extreme environments in deep space, where they will encounter harsh radiation and temperatures, particularly when travelling near the sun. The technology, which has been licensed by Irish company Enbio Ltd., solves major technical problems faced by spacecraft and over the last five years the coating has been rigorously tested for flight readiness by the European Space Agency and its industrial partners. The first spacecraft to use SolarWhite will be ESA's Solar Orbiter mission, which will launch in 2019 and will travel closer to the sun than any other man-made object.

SolarWhite will keep the Solar Orbiter mission and its onboard equipment safe from harm as it travels closer to the sun than any man-made craft ever has before.

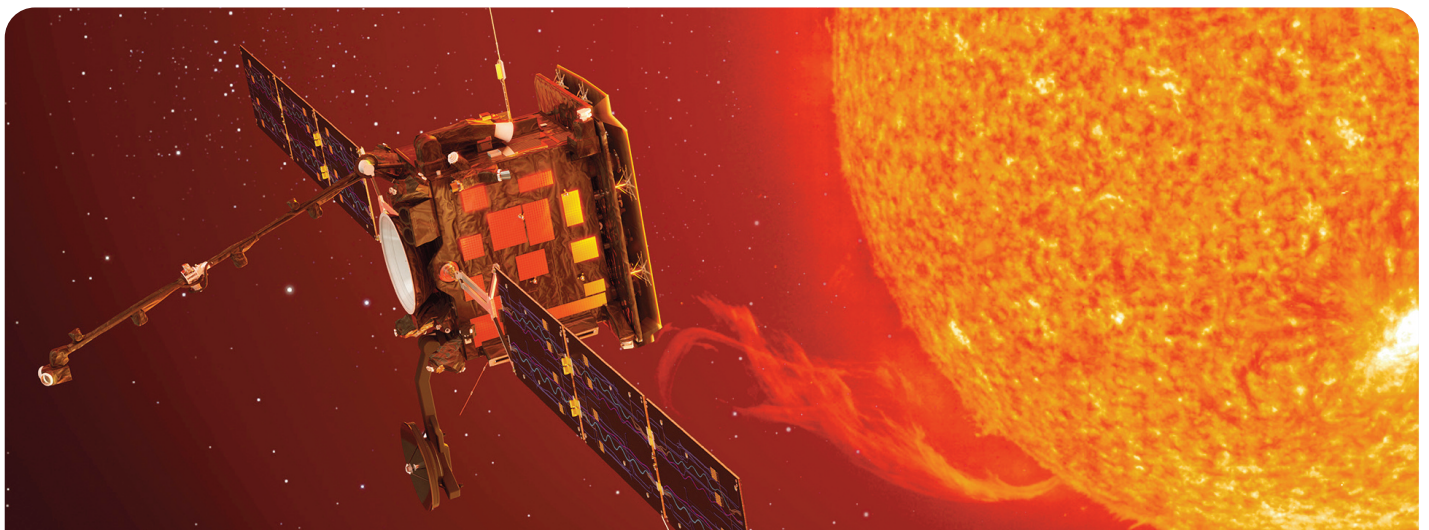
RESEARCH DESCRIPTION

Travelling in deep space has its challenges, but materials science and engineering can help. One way to protect spacecraft from the extreme environment of space is to use a special coating on the spacecraft structure, and Irish company Enbio Ltd had already come up with an ingenious blacker-than-black surface coating called SolarBlack.

The European Space Agency had been wondering if Enbio could come up with a white coating that could address the problems that they had been having for applications in deep-space missions, particularly the planned €1.7 billion Solar Orbiter mission, which will launch in 2019 and fly close to the extreme heat and radiation of the sun's surface.

Over coffee, Enbio's John O'Donoghue and UCD's Kenneth Stanton hatched a plan. An Irish Research Council Enterprise Partnership grant with a student called Kevin Doherty meant they quickly developed an initial material, and testing by ESA and partners showed great promise. Once the technology was patented, Enbio licensed it from UCD.

Since 2012, SolarWhite has been put through demanding paces to ensure flight-readiness. Steps have been taken to ensure that it can be made reliably and that it is reliable in service- after all, there is no way to fix it on the fly in deep space. Today, SolarWhite has been cleared for takeoff and this piece of Irish research and technology will keep the Solar Orbiter mission and its onboard equipment safe from harm as it travels closer to the sun than any man-made craft ever has before.



An artistic rendering of the Solar Orbiter spacecraft. Note the white radiator panels at the sides which will be coated with SolarWhite.

RESEARCH IMPACT

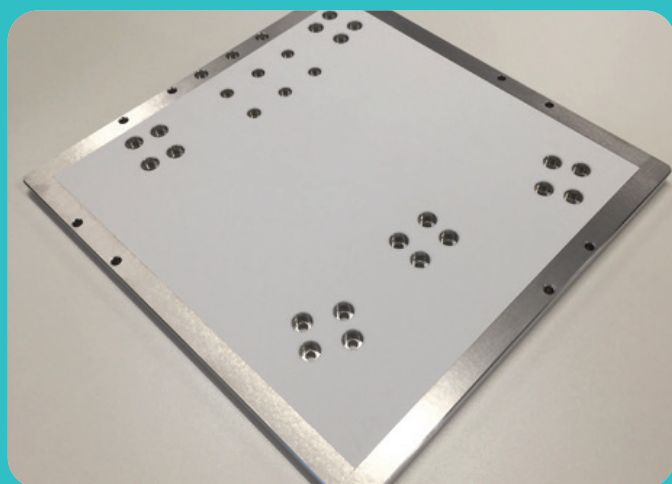
SolarWhite is making its mark in many ways. The white coating is enabling a key mission for the European Space Agency called the Solar Orbiter, to fly closer to the sun than ever before, and to collect important and ground-breaking new scientific information about our closest star.

Because of the technology developed at UCD and licensed by Irish company Enbio Ltd, the Solar Orbiter spacecraft can now be made in accordance with its technical needs: no coating other than SolarWhite is capable of meeting the mission requirements and it could not fly without it.

SolarWhite is an important development for Airbus Defense and Space, the primary contractor for the manufacture of the Solar Orbiter, as well as many other subcontractors working on the mission. As of April 2017, Enbio Ltd has coated more than 30 flight hardware components for these contractors, and most have been integrated into the spacecraft.

The invention has allowed Enbio Ltd to gain a firm foothold in the highly competitive space and aerospace markets. The infrastructure and personnel assembled through this growth phase, along with process and research and development expertise they have developed, has enabled Enbio to significantly broaden their market scope and product range.

The SolarWhite technology has facilitated the total investment in Enbio of €2.4 million by ESA and by industry. In turn, this has created high-tech jobs in Ireland: from 2012 to the end of Q2 2017, this has created 18 'full-time-equivalent' years of employment in Enbio and they have hired almost exclusively from UCD due to the exceptional quality of our engineering and science graduates.



A coated, flight-ready radiator panel for Solar Orbiter manufactured in the Enbio Ltd. Space Technologies Centre in Clonmel.

SolarWhite was also instrumental in ESA separately funding a €1.5 million state-of-the-art coating fabrication facility in Clonmel, Co. Tipperary. This facility, called the Enbio Space Technology Centre, opened in April 2015.

Plans and contract negotiations are ongoing for the future use of SolarWhite on other space missions such as the ARTES-14 Neosat Programme, which is Europe's next-generation telecommunications satellite platform, as well as in various other spacecraft.

SolarWhite also features on Ireland's first satellite - it will provide important experimental data on a 'CubeSat called EIRSAT-1' being developed by a team of scientists and engineers led by UCD that will be launched by the European Space Agency.

The associated patent for SolarWhite has been filed in all major space-technology territories including USA, UK, China, India, Japan and the EU.

The work on SolarWhite has led to several training and outreach benefits, including one PhD graduate and several internships for Masters in Materials Science and Engineering students. Kevin Doherty won the world finals of the IOM3 Young Persons' Lecture Competition in 2015 and SolarWhite has captured the attention of media in Ireland and internationally.

SolarWhite has even made an impact on broader culture - UCD Artist-in-Residence Siobhan McDonald featured SolarWhite as an artwork material in her work entitled, "Crystalline", which has been exhibited in Europe.



John O'Donoghue CEO of EnBio Ltd. (left), Damien English T.D. former Minister for Skills, Research & Innovation (centre), and Yves Bonnefous, Solar Orbiter Project Manager at the European Space Agency (right), at the opening of the Enbio Space Technology Centre, Clonmel, Co. Tipperary; this is a bespoke manufacturing facility for application of SolarWhite.



RESEARCH

Peer Reviewed Journal Article:

K.A.J. Doherty, C.F. Dunne, A. Norman, T. McCaul, B. Twomey, K.T. Stanton, "Flat absorber coating for spacecraft thermal control applications", *Journal of Spacecraft and Rockets*, 53, Issue 6, (2016), pp. 1035-1042. DOI: [10.2514/1.A33561](https://doi.org/10.2514/1.A33561)

Winner of IOM3 World Final of Young Person's Lecture Competition:

www.iom3.org/kevin-doherty-ireland

Patent:

www.google.com/patents/WO2016005397A1?cl=ar

Websites:

Enbio Ltd. corporate website: www.enbio.eu

Enbio Solar White website: www.enbio.eu/ucd-engineers-to-provide-protective-coating-for-solar-orbiter-parts/

Enbio SolarWhite Specification: <http://enbio.eu/wp-content/uploads/2016/06/SolarWhite.pdf>

European Space Agency Solar Orbiter mission homepage: <http://sci.esa.int/solar-orbiter/>

ESA Image Database: www.esa.int/spaceinimages/Images/2016/11/ENBIO_SolarWhite_coating

ESA Cubesat Competition

www.esa.int/Education/CubeSats_-_Fly_Your_Satellite/New_CubeSat_Teams_participate_in_Fly_Your_Satellite!_Selection_Workshop_at_ESTEC

Use of SolarWhite in Art:

Siobhan McDonald: "Crystalline":

www.siobhanmcdonald.com/projects/ts80mgkektzafyn3bjbsoob124uzca

Review of "Crystalline" in the Guardian (UK):

www.theguardian.com/science/blog/2017/mar/17/crystalline-doomed-arctic-expeditions-and-stars-collide-to-create-quietly-powerful-show

News Articles:

Engineers Ireland:

www.engineersjournal.ie/2015/02/10/enbio-coblast-ucd

Irish Tech News:

<http://irishtechnews.ie/enbio-startup-success-from-outer-space-to-ireland>

Funding for SolarWhite on Neosat:

o www.ucd.ie/innovation/newsevents/news/2017/april/enbiosecurescontractwithesa

o www.dcu.ie/2017/04/minister-halligan-congratulates-enbio-on-contract-worth-e650000-from-the-european-space-agency-company-to-develop-and-manufacture-advanced-surface-coatings-for-telecommunications-satellites-at-its-cl/

Minister English Opens Enbio Space Technology Centre in Clonmel, April 2015:

o www.ucd.ie/innovation/newsevents/news/2015/april/enbiosnew15mspacetechnologycentreopensinclonmel/

o www.enterprise-ireland.com/en/News/PressReleases/2015-Press-Releases/Minister-English-opens-Space-Technology-Centre-in-Clonmel.html



Quotes:

John Halligan TD: Minister for Training, Skills & Innovation, at the award of €650k for development of SolarWhite for Neosat:

"ENBIO is a prime example of how Irish technology companies can be at the forefront of ground breaking technology developments for the most demanding of space systems engineering. It is particularly encouraging to see such high-level space engineering activities taking place in the South East region".

Damien English T.D., former Minister of State for Skills, Research & Innovation, at the opening of the Enbio Space Technology Facility, April 2015:

"ENBIO has achieved remarkable success during its four-year development programme with the European Space Agency (ESA), which has brought over €1.5 million in ESA funding to Clonmel in addition to creating up to 12 new jobs in 2015 and into 2016. I congratulate the team at ENBIO and commend Enterprise Ireland for assisting the company to secure the €1.5 million contract from the European Space Agency."

Dr. Kevin O'Flynn, C. Eng., Business Development Officer for Enbio Ltd., from an interview with Simon Cocking, Irish Tech News, May 2015:

"Our SolarWhite coating was developed by a team led by Dr. Kenneth Stanton of UCD working in conjunction with ENBIO. It's a coating that will revolutionize white coatings in space and solve some major problems that have been happening with them. SolarWhite is now a major part of our product offering."