PhD Studentship (Sponsored by Lloyds Register Foundation) - Development of Self-Healing Coating systems for mitigating corrosion of offshore wind turbines.

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<th>Institution</th>
<th>National Structural Integrity Research Centre (NSIRC)</th>
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<td>PhD Supervisor</td>
<td>Dr David Weston</td>
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<td>Application Deadline</td>
<td>Open Until Filled</td>
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<td>Funding Availability</td>
<td>Funded PhD Project (Students Worldwide)</td>
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**Background**
Offshore structures are subjected to harsh environments. The combined effect of Sun’s UV radiation, seawater splash and fluctuating temperatures make the splash and tidal zone the worst of all. In addition, the possibility of damage caused by floating ice, seaborne debris, and inspection and maintenance boats makes the splash zone of any offshore structure the most vulnerable to the elements. A common method of mitigating corrosion of offshore structures is to use cathodic protection. This method of protection relies on continuous electrical and electrolytic contact between the offshore structure (made the cathode) and a more active metal/alloy (the anode). This method, however, is ineffective in the splash and tidal zone due to the lack of a continuous electrolyte (seawater) layer between the structure and the anode at all times. Although one may use a dielectric or sacrificial coating on the surface of an offshore structure to reduce anode consumption, the use of protective coatings become indispensable in the splash and tidal zone.

Protective coatings which rely entirely on their barrier properties offer little or no protection once breached. As damage is likely in the splash and tidal zone these coating systems need expensive inspection and maintenance regime to ensure long-term protection of offshore structures. Thus, a protective coating system which can heal itself when damaged can provide a cost-effective engineering solution to corrosion and related problems.

**Project Outline**
We will investigate the conversion of commercially available two pack epoxy based paints (for marine environments) to autonomous external self-healing paint systems via addition of suitable encapsulated healing agents and catalysts. The liquid healing agent capsules will be designed to rupture when the paint coating is damaged releasing the self-healing liquid which will then be exposed to the catalyst and solidify. During the time period between coating damage and the completion of the healing reaction, the substrate metal will be exposed to a corrosive environment, so the use of a sacrificial layer of Zn will also be investigated. The use of combined paint/electrodeposited coatings allows for further novel development of composite coating systems. For example, the paint could contain the liquid self-healing polymer capsules, but the catalyst could be contained in the metal matrix composite or nanocomposite. This would neatly side step one of the current problems with self-healing in that the catalyst is often reactive to the polymer system and becomes deactivated. In the proposed composite coating system the self-
healing reaction would occur at the metallic surface where it has been exposed, and protection is required. Paints will be chosen for their resilience to impact and further modified by additions of suitable matrix bonded fillers to promote an elastic response to impact. Colourants in the form of dyes will also be investigated which change colour during the self-healing reaction allowing identification of damaged areas to be performed with ease. The project will aim to develop self-healing coatings suitable for use in offshore splash and tidal zones. To ensure the suitability of any novel coating system in the splash and tidal zone certain industrial qualification tests need to be performed. Some of these qualification tests are outlines in the standards such as NORSOK M-501, ISO 20340, ISO 9227, AWS C2.18, NACE 12 etc. In addition, TWI recommends tests such as alternative immersion, cathodic disbondment, water vapour transmission, selective ion transmission, damage tolerance, coating adhesion etc to assess long-term performance.

**About Industrial Sponsor**
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**About NSIRC**
NSIRC is a state-of-the-art postgraduate engineering facility established and managed by structural integrity specialist TWI, working closely with, top UK and International Universities and a number of leading industrial partners. NSIRC aims to deliver cutting edge research and highly qualified personnel to its key industrial partners.

**About University**

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The University of Leicester is one of the UK’s leading universities, committed to international excellence through the creation of world changing research and high quality, inspirational teaching. Leicester is ranked in the top 2% of universities in the world by the QS World University Rankings and THE World University Rankings. In 2013 Leicester was the highest climbing UK university in the THE World Rankings, moving up 35 places to 161st in the table.

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### Candidate Requirements
Candidates should have a relevant degree at 2.1 minimum, or an equivalent overseas degree in Chemistry, Materials or Engineering. Candidates with suitable work experience and strong capacity in numerical modelling and experimental skills are particularly welcome to apply. Overseas applicants should also submit IELTS results (minimum 6.5) if applicable.

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<th>The NSIRC/TWI PhD funding is available to UK/EU and International* applicants.</th>
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<td>N.B. *The funding offers a stipend/salary package and a UK/EU fee waiver. International applicants must be able to fund the difference between UK/EU and International fees for the full 4 years of study.</td>
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### Funding Notes
This project is funded by Lloyds Register Foundation, TWI and academic partners. The studentship will provide successful Home/EU students with a stipend of £16k/year, plus £2k RTSG, plus the current rate of Home/EU fees. Overseas applicants are welcome to apply, with total funding capped at £24k/year.