Innovate UK

Results of Competition: Biofilms
Competition Code: 1506_FS_EMTECH_I_BF

Total available funding for this competition was £3M from BBSRC and Innovate UK

Note: These proposals have succeeded in the assessment stage of this competition. All are subject to grant offer and conditions being met.

Participant organisation names	Project title	Proposed project costs	Proposed project grant
WH Partnership Ltd Newcastle University University of South Wales	Online Microbial Fuel Cell Biofilm BOD Sensor	£89,811	£69,852
Project description - provided by applicants			
Monitoring of organic pollution in wastewater is a difficult challenge for the water treatment industry. Due toinfrequent sampling there is a high possibility that pollution could be discharged into the environmentundetected and lead to further problems downstream.Bioelectrochemical sensing systems are an emerging technology which uses biofilms grown upon electrodes toconvert organic pollution into electricity. Based on the amount of electricity generated, the amount of organicpollution can be determined. This approach can therefore be used to provide continuous online monitoring ofwastewaters in virtually real-time in comparison with existing measurements requiring 5 days.The project will deliver a prototype sensor based on Bioelectrochemical Systems , capable of being retrofittedto existing wastewater treatment plant infrastructure, in order to rapidly measure Biochemical Oxygen Demand(organic pollution) and Toxicity.ublic Project Summary			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Parkside Flexibles (Europe) Ltd SciTech Adhesives Systems Ltd Banham Poultry Ltd Institute of Food Research Bangor University	AntiCampylobacter BioFilm Technology (AC-BIT)	£99,483	£81,289
Project description - provided by applicants			
To prevent transmission in the human food chain this feasibility project will target control of biofilms formed bymicrobial pathogens in the meat supply chain. The work will be tested Campylobacter and Salmonella, two ofthe most common foodborne pathogens in the United Kingdom.A particular focus will be given to the possible inhibition and removal of such biofilms using natural products.The research will build-up on multi-disciplinary expertise in pathogen biofilm, meat supply chain processing,and natural product chemistry.This will underpin future research on the design of anti-biofilm products for the meat packaging or cleaningproduct industry, which will be used in subsequent projects for usage in cleaning products formulation for thefood industry, or in meat packaging (MAP trays, soaker pads or sealing foils).This work will have an impact on food poisoning, which represents a major challenge to the food industry, andto the National Health Service.			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Neem Biotech Ltd Membranology Ltd Jellagen Pty Ltd	Development of an active wound dressing built with electrospun jellyfish collagen and capable of delivering natural antimicrobial agents.	£98,322	£68,825

Project description - provided by applicants

Biofilms are present in chronic wounds and are known to contribute to continued infection and inflammationwith antibiotic resistance of biofilms complicating the problem. Current wound healing treatments areassociated with antibiotic resistance and often use mammalian (bovine) collagen treatments, which riskscontamination from disease causing agents such as prions (Bovine spongiform encephalopathy) andinterspecies viruses. In the present Feasibility Study, by embedding jellyfish collagen with novel plant derivedantimicrobials, it will be possible to produce a prototype product capable of delivering antimicrobial agentsdirectly to the wound and reduce the need for antibiotics.By combating biofilms in chronic wounds, the consortium will reduce the burden on the NHS and drasticallyimprove the quality of life of chronic wound sufferers. The wound healing product output of this project willaddress the current problems with wound chronicity that contribute to this growing problem in the UK.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Unilever UK Central Resources Ltd University of York	Real time visualisation & modelling of biofilm inhibition by lactam	£99,045	£74,069

Project description - provided by applicants

Microbial control actives drive hygiene performance or preservation in FMCG formulations, packaging, andprocessing. Today's petrochemical options are receiving safety, regulatory and NGO pressure and have beenshown to be ineffective on established biofilms on inert or biological surfaces. Current cleaning productscontain anti-microbial actives that improve surface hygiene and freshness by killing planktonic microbes. Thereis increased industrial interest in commercialising anti-biofilm technologies that push the boundaries in healthand hygiene. Furanone derived lactam analogues jam quorum sensing. To-date it is not fully understood whichstage(s) of the process they impact on. This project aims to visualise in real-time phenotypic changes to non-planktonic bacteria induced by a soluble lactam analogue and in tandem model the very earliest stages of non-planktonic cell-surface association to lasting impact on mature biofilm structure and functionality. Monitoringflow dynamics will shed light on cellular attraction and active diffusivity and help us identify the limitingfactor(s) in biofilm growth inhibition and design novel or complementary anti-biofilm technologies.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Unilever UK Central Resources Ltd University of Leeds	The use of beta-lactams to prevent biofilm growth in durable nonwovens	£100,000	£75,000
Project description - provided by applicants			
Within the nonwovens sector personal and household care, hygiene, medical and filtration products areconstantly challenged by microbial contamination. In durable nonwovens the hygiene problem is addressedmostly through anti-microbials such as silver and quaternary ammonium compounds. However these presentenvironmental and toxicological risks, are of limited efficacy on biofilms, and also present a risk of increasingmicrobial resistance. Recently the screening of a library of over 600 furanone derived lactams has revealedvariants that disrupt quorum sensing during biofilm growth and development. This feasibility project willexplore the application of these as anti-biofilm coatings on nonwoven textiles. Using different applicationtechniques during manufacture, analogues will be covalently and non-covalently bound within the matrices, orat the surface, of polyolefin and cellulosic materials. The efficacy and durability of the antifouling coating onnonwoven products will be explored and the possibility of a biotechnology platform that covers a range ofapplications across durable nonwoven market segments will be assessed.			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Adtec Europe Ltd Royal Hampshire Hospital NHS Trust Salford Royal Hospital NHS Foundation Trust	Efficacy on nonthermal gas plasma on sub-clinical wound infections (biofilms) in patients with diabetic ulcers	£100,000	£75,000
Project description - provided by applicants			
There is a need for support in the management of biofilms, although there is a growing interest in infectionmanagement, there is limited comparative information regarding wound care products and their efficacy onestablished biofilms. We believe non-thermal gas plasma (NTGP) has the potential to not only enable thehealing of chronic wounds that are stalled by sub-clinical wound infection (biofilm) but accelerate healing time.The intention of this investigation is to generate data that can be used as a guide by clinicians in themanagement of chronic wound infections. We believe this study has the potential to provide a significantadvancement in optimising chronic wound management and could be extended to other potential applicationssuch as treating biofouling in distribution pipes found in the food and water industries.Lead Industrial partner is Adtec Europe Ltd, with support from Mr Keith Cutting, Dr Paul Chadwick ConsultantPodiatrist, Ms Samantha Haycocks Advanced Podiatrist at Salford Royal NHS Foundation Trust, Ms Rosie LeggPodiatrist and clinical/academic partner Dr Matthew Dryden at the Royal Hampshire Hospital.			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Procter & Gamble Technical Centres Ltd University of Birmingham	New materials for managing biofilms (NEMAB)	£99,281	£64,640
Project description - provided by applicants			
The presence of biofilms in manufacturing can act as a source of product contamination, resulting in persistentquality issues, equipment failure (microbially induced corrosion) and an ongoing cost to manufacturingcompanies through ensuring their absence and removal. Ultimately, this results in a cost to the environment,through waste disposal, energy costs and water usage, and in the worst cases can impact on consumer health.This project looks to evaluate new materials which can be used in manufacturing to minimise the presence ofbiofilms and improve the cleanability of manufacturing processes. If the project is successful, we would look toimprove the environmental footprint of manufacturing, while improving the efficiency of delivering qualityproducts to the UK's consumers.			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Process Instruments (UK) Ltd University of Warwick	Biofilm Activity Analyser for Healthcare Applications	£89,786	£74,561
Project description - provided by applicants			
Biofilm formation associated with water storage units in the healthcare industry is a serious issue in e.g. dentalhealthcare and renal dialysis, due to potential bacterial infections. Biofilm build-up in the non-disposable plasticpipes connecting dental water systems and dialysis catheters, in particular, are a cause for increasing concernamongst healthcare professionals. Current monitoring techniques required as part of dental and dialysisguidelines do not provide continuous assessment of biofilm activity. Instead, monitoring is based on labtechniques, or dip-stick kits, which can take many days to complete. We aim to investigate the feasibility ofnew innovative technology based around biocompatible diamond electrochemical sensors, which can beminiaturised and placed directly in the appropriate tubing. The sensor will provide real-time, continuousfeedback on biofilm growth, thus immediately informing on "unsafe" biofilm levels and recommending biocidetreatment procedures. As the diamond sensor is chemically resistant long term placement is possible. Thisfeasibility study will be carried out between the SME Process Instruments and the University of Warwick.			

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5D Health Protection Group Ltd University of Liverpool	An Anti-Biofilm Synergistic Framework for Treating Chronic Wounds	£92,511	£72,064
Project description - provided by applicants			
This project is a collaboration between the 5D Health Protection Group Ltd and the University of LiverpoolClinical Engineering Department. The research and development collaboration will enable the development ofthe next generation antibiofilm technologies that can be applied to medical platforms for enhancing clinicaloutcome. One important area for use of this technology would be woundcare considering now that chronicwounds have been shown to now contain biofilms. Many complex biofilms found in non-healing and infectedchronic wounds are recalcitrant to presently used antimicrobial interventions. Furthermore these interventionsare often overused and have no enhanced clinical benefit. In addition the project will involve the developmentof a framework that involves the intelligent triggered release of synergistic agents for maximum impact andreduced hospital costs. Presently such technology does not exist in the market so this innovation will create thefirst world leading prototypes and advanced technolgies that presently do not deliver to the expectationsrequired for biofilm management in non-healing and infected chronic wounds.			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Unilever UK Central Resources Ltd Manchester Metropolitan University	Real time visualisation & modelling of biofilm inhibition by lactam	£99,774	£74,805
Project description - provided by applicants			
Beyond removal of dirt, home and personal care formulations such as laundry detergents, kitchen and bathroomcleaners aim to deliver health and hygiene benefits in line with Unilever's Sustainable Living Plan. These benefitsare currently delivered by chemical antimicrobials which have a limited efficacy on established biofilms. Thescreening of a library of over 600 furanone-derived lactams has revealed variants that disrupt quorum sensingand biofilm growth in model environments. This feasibility project aims to enhance the bioavailability andefficacy of lactams in home care applications via rational modification of existing principal analogues. Possibleroutes of derivatisation will range from introduction of charged groups for solubility, enhancing the 'active site'functionality, and grafting complex polymeric lactam-containing materials for targeted delivery to surfaces andbiofilms. A focused library of around 10 novel analogues will be constructed, synthesised, and their anti-biofilmefficacy will be explored against real biofilms on a range of home and industrial surfaces. The platformopportunity of improved lactams in home care will be assessed.			

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The PJH Partnership Ltd	Investigating the use of SCO2 to impregnate medical materials for the prevention of microbial biofilms	£60,935	£42,654
Project description - provided by applicants			
The PJH Partnership Ltd have developed supercritical technology that when used with an anti-bacterial dopant,may prevent the formation of biofilms on medical device materials. Through a series of experiments andindustry engagement, PJH will undertake a 10-month programme of work to validate process efficiencies andperformance, in terms of the depth and volume of deposition, effective dispersion, dopant characterisation,and material evaluation and economic assessments. This approach draws upon the impregnable performanceof supercritical CO2 and patented technology and test methodologies. Test materials will include industryapproved implant devices, from which ongoing medical trials are scheduled to confirm anti-bacterial effects forbiofilm prevention. Assessment across plastic and metal materials will determine the scope of use, with widerapplications in the healthcare industry. Following this 10-month study, medical trials will be undertaken priorto commercialisation, envisaged 2018.		

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International Paint Ltd University of Southampton	Measuring predictors of drag penalty of ship-fouling biofilms	£99,388	£73,685
Project description - provided by applicants			
Biofilm fouling on ships leads to costly drag penalties, and the marine coatings industry seeks to developtechnologies that will eliminate or reduce "slime". This project explores the feasibility of using marine foulingbiofilm mechanical and physical properties as predictors of associated drag, and thus more sophisticatedmetrics of coating performance than the current standard. Biofouling and coatings experts at InternationalPaint Ltd. and biofilm mechanics experts at the Univeristy of Southampton will partner to develop and validateinnovative methods and apparatuses for measurement of (i) biofilm drag and (ii)mechanical/physical propertiesof intact, immersed biofilms on marine coatings. With these methods, the teams will compile the first datasetof biofilm drag penalties with respect to the mechanical/physical properties of these compliant materials. Thetest methods and broader knowledge of biofilm properties and drag will directly benefit coatings research anddevelopment, product performance modelling, and fundamental materials science.			

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Bioquell UK Ltd	Evaluating the efficacy of H2O2 vapour against biofilms formed by multi-dru resiatnt organisms (MDROs)	£51,337	£30,802
Project description - provided by applicants			
The project aims to evaluate the efficacy of Bioquell's 35% hydrogen peroxide vapour (HPV) technology againstsingle and multi-species biofilms, produced by multi-drug resistant organisms (MDROs) associated with hospitalacquired infection. Recent evidence shows that biofilms can survive in excess of 12 months on surfaces withinhospital rooms, even after terminal cleaning with bleach. It is believed that these biofilms act as reservoirs forinfection, with the potential to contaminate patients who come into contact with them. Bioquell is working inconjunction with University of Southampton.			

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MOFgen Ltd	Biofilm management in wound healing using Metal Organic Frameworks (MOFs)	£99,300	£69,510
Project description - provided by applicants			
This project aims to explore the feasibility of using a new class of chemical compound called Metal OrganicFrameworks (MOFs) to deliver antimicrobial metal ions and nitric oxide (NO) gas for the wound managementmarket. The purpose is to prevent biofilms forming in wounds and to increase healing rates (NO is bothantimicrobial and a wound healing promoter).			

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Clear Water Revival Ltd University of the West of England	Management and use of beneficial bacterial biofilms to control aquatic pathogens, for reliable chemical-free sanitisation of swimming pools	£99,821	£80,422
Project description - provided by applicants			
The swimming pool filtration market (worth 3.2bn) currently lacks chemical-free alternatives despitecustomers' demands of healthier, easier and cheaper solutions to pool water treatment. This project helps tofully realise the mass market potential for natural bio-filter based water treatment technology, throughinnovative and robust scientific research and development into aquatic pathogen behaviour and control usingbio-films. Project Objectives: Determine how our biofilms reduce levels of waterborne pathogens; ascertainwhether bio-films housed within a bio-filter allow re-introduction of pathogens in water; develop optimalhabitats & management of biofilms to maximise pathogen removal; & quantify pathogen survival rates on full-scale filtration models. The invaluable knowledge gained during the project will enable a set of optimisedoperational parameters (eg: optimal PH/ flow rates) and substrate properties (eg pore size, depth), whichmaximise the efficiency, repeatability and reliability of biofilm performance (w.r.t. pathogen control) for real-world conditions.			

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BioFilm Solutions Ltd	A feasibility study to determine the effectiveness of a novel polymer coating in reducing biofilm formation within beer dispense systems.	£85,285	£59,699
Project description - provided by applicants			
Biofilm Solutions is a micro company created to exploit a novel method of reducing biofilm formation withinbeer dispense systems. We have been granted exclusive licensing rights to explore the potential applications andbenefits of this innovative technology. A recent study with our research partner demonstrated a significantreduction in the build-up of biofilm on the inner surface of a beer dispense line using our product. The aim ofthis project is to assess whether this innovative technology can effectively control biofilm formation in beer linesin a dynamic, simulated pub environment. Keeping beer lines clear of biofilms wastes over 500M litres of waterand 70M pints in the UK alone. Our product could significantly reduce the frequency of line cleaning resulting inless wastage of beer, water and a reduction in chemical cleaner usage. It would also improve the maintenance ofbeer quality. A successful outcome would prove commercial viability and demonstrate major benefits for themanufacturer, the proprietor, the consumer and the environment.			

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Medtrade Products Ltd	Biofilm Combatting Technology for Wound Care Application	£98,939	£59,363
Project description - provided by applicants			
This project is focused on Wound Care where 60% of chronic non-healing wounds possess micro-organisms in abiofilm form causing a significant social and economic impact. It has a negative effect on patient quality of liferesulting in a large impact on the health care system in terms of cost and resource. This novel technologydestroys biofilm formation. The objective is to completely challenge the biofilm combatting technology usingcomplex biofilm models that mimic chronic wound scenarios and to determine it's optimum capability.			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
NCIMB Ltd Probiotics International Ltd	Neutralising the harmful effects of dental biofilms by bacterial replacement therapy	£99,705	£66,813
Project description - provided by applicants			
Dental caries is a widespread oral disease that is costly for health services to treat, and causes pain and loss ofteeth to those affected. It is caused by production of acid by oral bacteria in biofilms on the teeth and gumscommonly known as dental plaque. Brushing teeth can reduce this problem, but many people do not do soregularly or thoroughly. This project will investigate the application of bacterial replacement therapy in theform of a lozenge containing a suitable probiotic strain to help develop an anti-caries environment within thedental plaque biofilm. The project will combine the strengths of two UK SMEs, a world class culture collectioncentre and a leading probiotics manufacturer. The project will investigate strains held within the NCIMB culturecollection for their potential to create novel biofilms to combat dental caries..			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Anacail Ltd	Biofilm management in Food Processing Environments	£97,898	£68,529
Project description - provided by applicants			
Ozone is one of the most powerful biocidal agents known to science: bacteria, spores, viruses and biofilms areall susceptible to destruction by ozone. Anacail are currently developing the technology for the food packagingindustry through the treatment of sealed packs. The technologyhas potential application in a linked area:reservoirs of contaminated liquid (drains) in food processing plants. Parallel work in assessing ozone on anumber of pathogens and has shown the potential for ozone to treat biofilms. With InnovateUK supportAnacail will develop and evaluate in real factory environments, a prototype for destruction or growth inhibitionof Listeria in food factory drain wells thus reducing infection spread and cross-contamination.			

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Varicon Aqua Solutions Ltd Plymouth Marine Laboratory Durham University	Development of a Novel Membrane Photobioreactor, for cultivation of Haematococcus pluvialis as Biofilm	£107,846	£69,892
Project description - provided by applicants			
Microalgae have the potential to produce an array of compounds in a manner more sustainable than theconventional petrochemical industry. This project aims to explore a novel and innovative method to producealgal biomass and bio-products at lower costs than conventional production systems. Namely we aim toinvestigate the commercial opportunity of using a proprietary membrane photobioreactor (MBR) to producethe high value pigment astaxanthin from a biofilm of the microalgal strain Haematococcus pluvialis.			

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Gama Healthcare Ltd University of Huddersfield	The management and use of biofilms	£89,230	£69,557
Project description - provided by applicants			
Products derived from this project will enhance patient safety and aim to reduce the incidence of small surgicalsite infections and catheter related infections. Dealing with biofilm protected organisms is seen as animportant step in improving clinical outcomes in a number of medical cases. Novel formulations proposed inthis project potentially offer a significant step in this respect.			

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NCIMB Ltd	Management and control of biofilms in the oil and gas industry	£85,176	£59,623
Project description - provided by applicants			
Microbial biofilms can cause significant economic and environmental issues in oilfield systems from reductionin flow rates, souring of crude oil and contribution to corrosion of concrete and metal surfaces. Currentmethods for the control of biofilms in these situations include the use of chemical biocides which are expensiveand can lead to environmental contamination. This project will evaluate the application of bacteriophage as anatural alternative for biofilm control in oilfield systems. Although phage technology is not novel in itself itsapplication it has not been used actively in industrial situations. This project will evaluate the application ofphage technology for biocontrol for assets in the UK North Sea continental shelf.			

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