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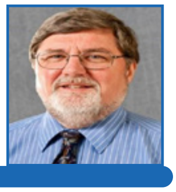

Next generation industrial biocatalysts: Concentrating and stabilizing live cells on surfaces or in flexible biocomposite materials to intensify reactivity

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Abstract

Model systems investigated by our group using bacteria, yeast, cyanobacteria, and algae have shown that nanoporous adhesive biocoatings and flexible biocomposite materials (microbial paper) can concentrate and stabilize live cells for 1,000 of hours, intensify biocatalysts, and reduce water use for large scale bioprocesses. Biocoatings can be generated by industrial coating, ink-jet printing, aerosol delivery, and fiber wet-lay methods followed by controlled drying. Generation of waterborne adhesive wet adhesion and nanoporosity with microfluidic networks surrounding the embedded cells are a function of arresting polymer particle coalescence during drying. Nanoporosity is critical to preserve cell viability. A second key technology is lyoprotection during drying by the addition of lyoprotectants or cellular engineering for cells that are not naturally desiccation tolerant. Model systems have demonstrated the sustained reactivity of cells that carry-out photosynthesis, liquid or gaseous carbon capture/recycling, generate oxygen, bio-sense, are vaccine substrates, or chiral bioconversions - all can be dried, rehydrated and remain active. Biocomposites are now being investigated to engineer multi-layer biomimetic leaves combining different types of photosynthetic cells that could exceed the carbon capture reactivity of natural leaves, reactive architectural coatings that respond to sunlight or pollutants, and for processing large volumes of carbon containing gases. Live cells embedded in or on the surface of paper can use thin liquid films for gas-liquid mass transfer without generating bubbles. Enhanced mass transfer with reduced energy input has been demonstrated using thin falling liquid films over rough paper in a prototype falling film bioreactor (FFBR). A FFBR could dramatically reduce both energy and water use to process waste gas to chemicals. Dry stabilization of live cells will enable centralized biocatalyst manufacture, elimination of the cold chain in transporting concentrated cells or vaccines, and modular continuous manufacturing. Future development will lead to the waterborne coating, specialty paper, and nonwoven materials industries expanding the functionality of paints, inks and composite materials by incorporating engineered.

Biography

Michael C Flickinger received his graduate training in microbial and pharmaceutical biochemistry from the University of Wisconsin (Madison, WI, USA) and post-doctoral training in the School of Chemical Engineering at Purdue University (West Lafayette, IN, USA).

Publications

1. Publication I: A Falling Film Bioreactor (FFBR) for Generating Effective Gas-to-Liquid Mass Transfer using Wavy Laminar Flow for Continuous Microbial Gas Processing
2. Publication II: Experiments and finite element modeling of hydrodynamics and mass transfer for continuous gas-to-liquid biocatalysis using a biocomposite falling film reactor
3. Publication III: Fabrication of Photoreactive Biocomposite Coatings via Electric Field Assisted Assembly of Cyanobacteria
4. Publication IV: Microbial Paper: Cellulose Fiber-based Photo-Absorber Producing Hydrogen Gas from Acetate using Dry-Stabilized Rhodopseudomonas palustris
5. Publication V: Dynamic adsorption of ammonia: Apparatus, testing conditions, and adsorption capacities

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