NELUMBO - SUPERHYDROPHOBIC COATINGS FOR HVAC

APPLICANTS & AFFILIATIONS

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PARTNERS

Nelumbo will be partnering with CITRIS, the SinBerBEST program, BECI, and the UC Campus to provide a pilot demonstration of the technology on an Air Conditioning unit located in Sutardja Dai Hall. The exact details of the partnership are still in the works, but it is known that the capital required will be split between the parties in a collaborative effort.

INTELLECTUAL PROPERTY STATUS, PATENT OR TECH TRANSFER NUMBER(S)

US Provisional Filed, Utility in progress

TIME TO MARKET - Within the next 12 months

C2M OBJECTIVES

In depth market analysis for current focus and select alternate potential applications. Business model(s) based on a business-to-business revenue streams between Nelumbo and air conditioning manufacturers, and/or other relevant industrial corporations.

We have looked into OEM subcontractor coating models where the company will coat evaporator coils as part of the production line. Alternatively, we have looked into licensing models where we would sell the coating solutions to the coil manufacturers. C2M ideally would help us choose the optimal starting business model.

TECHNOLOGY

OMNIPHOBETM is a thin omniphobic (water and oil repellent) nanocoating that may be universally applied on any scale or geometry. Applying this to air conditioning cooling coils allows them to run dry, increasing efficiency up to 25% by reducing water fouling. The coating also protects against corrosion, increasing the unit lifetime and reducing maintenance.

The surface coating has been characterized fully on a materials level and optimized for condensing heat transfer surfaces. A small-scale heat exchanger prototype has been created for a lab-scale wind tunnel to obtain the properties and monitor energy data. This is currently operating and data has been obtained for a wide range of conditions. The field prototype 5-ton HVAC unit is currently being ordered with a 4-week lead time with a realistic deployment date on the roof of Sutardja Dai Hall in July. From there, 1 year of energy data will be obtained and compared with the baseline coil that has been logged over the past
CUSTOMERS

A typical air conditioner (from residential to commercial scale) has many inefficiencies due to a phenomena known as water fouling, where water from the air will stick and clog the fins of the "cooling coil" piece. This drives energy costs up and also lowers air quality, as mold and fungal infections from the standing water on the cooling coil will distribute bacteria particles throughout the air. Nelumbo's plan to mitigate both of these issues is to apply OMNIPHOBE to those cooling coil fins - the water will instantly shed as it contacts the fin, allowing the first ever cooling coil that "runs dry". This lowers energy costs and increases air quality for building occupants. Additionally, it provides large value to AC manufacturing companies who won't need to send maintenance crews as often to clean the dirty cooling coils, due to the self-cleaning property of the coating (as water wicks off the surface, it drags contaminants away). This self-cleaning property is expected to significantly reduce the maintenance costs of units and increase the longevity by preventing salt corrosion.

SCALING

The scaling process begins with an initial test on one segment of cooling coils for a large air conditioning manufacturer through a strategic partnership. Once the added value of our technology is established, adoption on larger volumes of product will rest on our ability to increase throughput for the coating procedure. Because the coating has been designed for application in a simple dip-coat process, we are able to scale to any demand by simply increasing the size of our chemical tanks and automating in batch format. We will be able to scale to suit demand for our partner, who we will work with to source appropriate installation locations throughout existing manufacturing settings, to ensure minimal disruption and thus maximal margins on the added value.

ADVANTAGES

Current HVAC and heat exchanger coatings are designed to prevent corrosion to the aluminum fins. These coatings are either made of thermally insulating polymers (Technicoat, Heresite, Nu-Calgon, Luvata) or are plated with a corrosion resistant metal (HVAC Armor). By coating the evaporator coil in polymers, the heat transfer coefficient is drastically reduced, adversely affecting the efficiency of the unit. Furthermore, coating with other metals gives a hydrophilic surface termination allowing for standing water on the fins which hurts heat transfer even more. Our OMNIPHOBE coating is the first coating designed to allow for dropwise condensation and rapid droplet shedding. In addition to preventing corrosion like our competitors, our
coating is thermally conductive, prevents standing water, is self-cleaning, and increases the efficiency of operation. Emerging competitors in the hydrophobic coating field are almost all polymeric-based and cannot compete in the heat exchanger market.

**BARRIERS**

The key risks to commercializing our coating will be pushback from incumbent technologies and resistance to initial adoption. We intend to increase the likelihood of rapid early adoption in a data-driven manner. We have laid out more than two dozen industry standards (such as NIST, ASHRAE, ASTM), which will demonstrate the durability, longevity, corrosion-resistance, and bio-resistance of the coating. Bosch has suggested these standards as needed indicators to adopt our technology. We have begun durability testing, and are sending samples to multiple test facilities in order to receive certificates for the other metrics. This will allow us to combat any question of the coating’s ability as we negotiate a partnership. From initial testing, the coating outperforms all other products to such a degree that we will be able to move through any rival resistance. Proving our value to one company will cause a shift towards Nelumbo’s product.

**FEEDBACK**

While we have not formalized an agreement with any one institution or company, we are currently in talks with Bosch, JTC (Singapore based), and Chevron. The unanimous response has been that our technology has immediate potential, and could be incorporated in multiple processes beyond our initial start point of air conditioning. Each company has suggested their own set of standards they would like to see in order to move to move forward and test our technology at their site, culminating in a potential partnership.

Additionally, we have attracted the interest of the Berkeley Angel Network. We have received a letter of interest from one of their investors and are compiling a list of other potential investors.

**ACADEMIC/JOB TITLE(S) - Student, Postdoctoral Scholar, Assistant Professor**

**STATUS**

Other DOE funding, Customer pilot(s), Bench scale prototype(s), Significant lab performance data, Founder(s) only—also just won the $100,000 Berkeley Cleantech University Prize
TIME TO MARKET BACKGROUND

As stated previously, the main barrier to initial entry in our current market is establishing a strategic partnership with one of the major AC manufacturers. This industry is relatively conservative, meaning there will be a significant amount of data needed to convince them to adopt our technology on their product lines. In fact, many potential partners will want to test the technology in their facilities first before it reaches their final products. The time to market then primarily rests on these two facets: a test period of the technology in a partner’s facility (which we estimate could take up to 6 months), and our ability to collect broad and deep characterization data on the coating (while this will be an ongoing need, we believe 6 months to 1 year will be enough time to amass a critical amount of data to make the technology more readily applied).
OMNIPHOBETM heat exchanger coating

A water- and oil-repellent coating for application to air conditioning cooling coil fins.

- Increased energy efficiency
- Increased air quality
- Increased fin durability
- Streamlined dip-coat application

Description

NelumboTM has developed a superhydrophobic coating based on ceramic nanotechnology. This coating is uniquely scalable and cost effective. The target application is aluminum cooling coil fins where the coating will decrease typical fouling, increasing the efficiency of the air conditioning system. Additionally, circulated air quality and fin durability both increase. Due to ease of manufacturing, the coating may be applied to bare aluminum fin stock as well as pre-manufactured cooling coils. Once applied, the servicing frequency of the unit will also be significantly reduced.

How does our product work?

Air conditioning cooling coils have not evolved in design in the last 50 years and as such have long standing inefficiency issues. Primarily, water can film between cooling fins. This prevents more water from condensing out of the air, meaning humid air must be cycled many more times to achieve desirable humidity and temperature levels. With our OMNIPHOBETM coating, water fouling is no longer an issue due to its advanced shedding capabilities. This not only increases the energy efficiency, but also the quality of building air, as there is no longer a breeding ground for bacteria and mold spores in the trapped standing water. Shown above is a comparison of a water droplet on a typical aluminum fin to a water droplet on our material, highlighting the outstanding hydrophobic and water shedding properties of the product.

Application process

NelumboTM utilizes a three-stage dip coat process to grow the coating directly onto the aluminum fins for strong adhesion and long-term durability. The process has a treatment time of less than 2 hours and could be added to pre-manufactured coils or by roll-to-roll processing to aluminum fin stock.

What is our competitive advantage?

- Thermally conductive—no decrease in heat transfer, unlike typical polymer coatings
- Application process applicable to any cooling coil geometry
- Cheap, low-cost, and commercially available precursors
- Coating is chemically and mechanically stable, protecting the coil from abrasion and corrosion
- Water-shedding properties eliminate bacterial and fungal breeding grounds, increasing air quality
- Outperforms all other hydrophobic materials

Safety details

Our coating is comprised of compounds that are commonly used in sun screen lotions and non-stick cookware that have been used for decades. The coating is thermally stable to 200 °C, and in the small chance the coating was to chip or flake, the particulate would be captured by the air filters.

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