SUPREME

SUstainable nanoPaRticles Enabled antiMicrobial surfacE coatings

Textiles | Metal | Alloys | Ceramics | Tiles | Marble | Stone slabs | Paper | Cardboard | Plastics

BREAKING NEWS

Welcome to our second SUPREME Newsletter, created to put you up to speed with the project's news and achievements! For continuous updates, follow us on LinkedIn and Twitter, or check out our news website section.

Many thought-provoking discussions and exciting progress at the SUPREME General Meeting, on the 26th and 27th of September, 2023 in Crete, Greece, hosted by George Kiriakidis (PCN) and Vassilios Binas (FORTH).

SUPREME Consortium in Crete, Greece

STAKEHOLDERS' MAP VALIDATION WORKSHOP TOOK PLACE AT THE CRETE CONSORTIUM MEETING.

Groups of the Stakeholder's Map Validation

Textile Group

Metal and Alloys Group

Building Materials Group

Paper and Cardboard Group

Plastics Group

SUPREME working groups during stakeholders' map validation workshop in Crete, Greece

FIRST VISIT TO SUPREME INDUSTRIAL PARTNER WAS AT PCN MATERIALS IN CRETE

SUPREME consortium visiting PCN Materials in Crete, Greece

MAIN TOPIC: WHY CONVENTIONAL COATINGS ARE NOT A SUITABLE SOLUTION?

The COVID-19 pandemic has drawn a worldwide attention toward the transmission of contamination facilitated by high touch surfaces [1]. According to the literature, 20% of all fatalities in the world are attributed to infectious diseases, 80% of which occur via microorganisms (bacteria, fungi, and viruses, etc.) contaminated surfaces [2,3]. Some microorganisms are able to attach to a solid substrate and subsequently form biofilm, leading to severe spread of infections [4]. Biofilm formation not only causes the transmission of infection [5], but also reduces the longevity of products in various sectors, for example, the biomedical devices, food packaging, agriculture, textile, paint, marine transportation [4,6–8]. For control and prevention, antimicrobial coatings are heavily relied upon. Figure 1 illustrates applications of antimicrobial coatings [9]. There are three major approaches for designing antimicrobial coatings on the surface: anti-adhesion, contact-killing, and slow releasing [10,11]. Based on these approaches, a broad spectrum of materials such as fungicides, bacteriostatic, synthetic polymers, metal oxides, composites, nanoparticles, nanocomposites, etc. have been utilized recently [4].

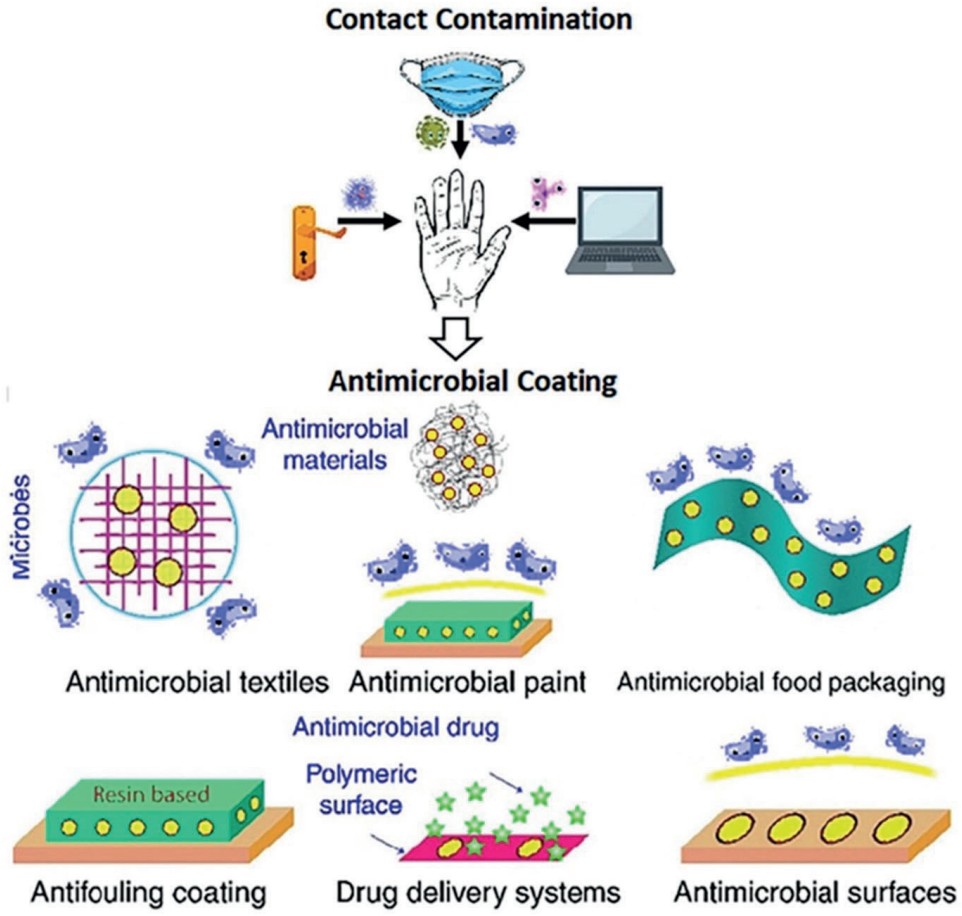

Figure 1. Antimicrobial coatings for various applications [9].

With the continuous development of biomaterials, considerable advance has been achieved in terms of antimicrobial coatings. However, there are yet a range of challenges that limit the wide usage of antimicrobial coatings, including longevity, toxicity (both human and environment), sustainability, tactile perception, and economic costs [3,12].

Longevity is the most prominent issue when it comes to using antimicrobial coatings on high traffic objects – materials of various chemical nature, e.g. food, lotion, sweat, sebum, cleaning agents, could be applied on the surface upon contact. A thin film of such, even tens of µm, could effectively inhibit the antimicrobial efficacy of the antimicrobial coating that has been tested and validated under laboratory conditions. Mechanical durability is part of the consideration for longevity – coating materials with excellent antimicrobial effectiveness but low wear resistance could not be considered as a commercial solution for high traffic objects.

Toxicity to environment and human is another critical factor for consideration. For instance, ZnO nanoparticles were studied for their antifungal properties and deployment in active food packaging. Although they are able to penetrate cell envelop of fungi, delivering the antimicrobial function they might trigger the formation of reactive oxygen species (ROS), harming living systems [13]. In here, concentration of usage is important for toxicity evaluation. Quaternary ammonium compounds (QACs) are widely used as spray coating in surface hygiene products due to their broad antimicrobial spectrum. However, the positively charged secondary amine groups could potentially cause harmful impact to mammalian cells [14,15]. As such, the Safe- and Sustainable-by-Design framework proposed by the European Commission could be an excellent guidance for the future design of coating materials.

Super-hydrophobic materials such as polytetrafluorethylene (PTFE) or hierarchically structured coatings have garnered great attention due to their low surface tension, which minimises the possibility for bacterial adhesion and biofilm formation [16]. However, the mechanical durability of hierarchically structured coatings could be a limiting factor. Coatings with low surface energy, instead of PTFE (due to the environmental concern of PFAS), might deliver the desired antifouling properties. However, proteins presented in biological fluids could attach to such surfaces via hydrophobic interaction, and subsequently render the surface properties completely.

Regarding the disadvantage of short-term sustainability, various conventional antimicrobial coatings are not able to be immobilized on the substrate for a long time because of their unstable physical-chemical characteristic as well as weak wear resistance in complex biological environment. QACs, which were mentioned above, normally form a

monolayer on the substrate surface but cannot resist abrasion. The antimicrobial activity is lost after the surface layer is worn off [17]. Hydrophilic polymers such as poly(ethylene glycol) (PEG), poly(hydroxypropyl methacrylate) (PHPMA), poly(hydroxyethyl methacrylate) (PHEMA), or zwitterionic polymers (Phosphatidylcholine type, Phosphatidylcholine type and sulfobetaine type, etc.) could provide exceptional antifouling properties due to the steric effect induced by the surface immobilized polymeric chains, but they would only work in aqueous environment, which is not suitable for the primary application, high traffic objects in ambient.

Antimicrobial coatings are fundamentally critical to the stability and resilience of global society, as well the preparedness for any future pandemic. Since the COVID-19 pandemic, there has been a surge of various hygiene products related to antimicrobial requirements, not only for hospital surroundings but also for surface protection, antimicrobial fabrics, and biocidal materials [9]. Therefore, conventional coatings are not a suitable solution in the future, because it is highly desired to focus on the development and manufacture of antimicrobial coatings with non-toxicity, long-term functionality, and low-cost [3,21].

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INTERVIEW CORNER

Büşra Erol
KU Leuven

Role @ SUPREME

"I am a PhD researcher at BioTeC+ - Chemical & Biochemical Process Technology & Control at KU Leuven and I'm responsible for antibacterial testing of nano materials developed by the SUPREME Project. These nano materials are to be applied in different kind of surfaces and also for different environmental conditions."

Two words that come to your mind when you think about coatin

"Pathogen and sterile"

How your work @ SUPREME will change people's life in the future

"Actually today, after coronavirus, people and scientists have understood the importance of health associated infections, especially caused by pathogen bacteria. These infections have high mortality rates, and they result in huge economic losses, and the surfaces are the main transmission way of the infectious pathogens. So, with SUPREME developments an unaccounted number of materials will have great potential to prevent such infections by applying them to high traffic surfaces. Some in the project selected pathogens account for almost 80% of these infections. So, showing their effectiveness against these pathogens has a very crucial role in terms of prevention of health associated infections caused by surface transmission."

Three products of every-day life where SUPREME technology will be implemented in ten years

"Face mask, door handles, and packaging materials"

INTERVIEW CORNER

Dr. George Kiriakidis
PCN Materials

Role @ SUPREME

"I'm the CEO of PCN Materials, the company committed to supply pristine Photocatalytic core material for the SUPREME project."

Two words that come to your mind when you think about coatin

"Effectiveness and durability"

How your work @ SUPREME will change people's life in the future

"I think we will have a major input if it's successful simply because we're talking about the surfaces with which we get in contact and in the proximity with for the major part of our daily life and so forth. So making sure that these coated surfaces are virus and bacteria free, it's very important for everybody's health."

Three products of every-day life where SUPREME technology will be implemented in ten years

"Paint (wet and powder), spray coating on different surfaces like fabrics, and cellulose products like packaging applications for high volume high traffic products of today's delivery."

WHAT'S HAPPENING?

What?	Who?	Where?	When?
SUPREME Consortium General	ALL	Crete, Greece	26 - 27.09.2023
Researcher's Night 2023	PCN	Crete, Greece	29.09.2023
Innodays - Innovation Days of the Region of Crete 2023	PCN	Crete, Greece	24 – 26.11.2023
MRM2023/IUMRS-ICA2023 | Advanced Materials Research Grand Meeting	PCN	Kyoto, Japan	11 – 16.12.2023

WHAT'S NEXT?

What?	Who?	Where?	When?
FOODSIM 2024	KUL	Ghent, Belgium	7 - 11.04.2024
European Symposium on Surface Science (EMASST)	PCN	Athens	17 - 19.04.2024
MaterialsWeek 2024	RIVM	Cyprus	17 - 21.06.2024
Elements of Future – XXVIII National Congress of Società Chimica Italiana	NTT	Milano	26 - 30.08.2024

Looking forward to SUPREME Newsletter # 3 in June 2024!

CONSORTIUM

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