

# **Eco-active Porcelain Grés Large Slabs: the Perfect Symbiosis between Environment and Building Materials**

C.L. Bianchi<sup>1</sup>, C. Diazzi<sup>2</sup>, F. Minozzi<sup>3</sup>, V. Capucci<sup>3</sup>

<sup>1</sup>Univerità degli Studi di Milano, Dept. of Chemistry – 20133 Milano, Italy

<sup>2</sup>Iris Ceramica – FMG – 42042 Fiorano M.se, Italy

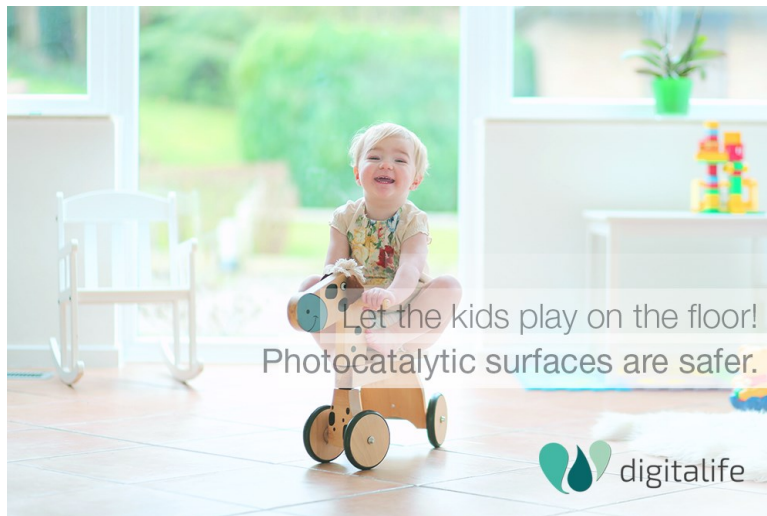
<sup>3</sup>GranitiFiandre SpA – 42014 Castellarano, Italy

Exposure to air pollution represents one of the most important health hazard for either mankind and all the ecosystem, pollution that is not present only outdoor but also indoor. Contrary to what is generally assumed, air in several indoor environments is often more polluted than outdoor air. This is because of the many sources of indoor pollution, which include mold and pollen, tobacco smoke, household products and pesticides, and materials usually used in buildings such as formaldehyde and organic compounds in general. Health effects from indoor air pollutants generally occur after long or repeated periods of exposure and they can be severely debilitating or fatal and we have also to consider that, mainly in the urban areas in more developed Countries, population passes most of the time in closed rooms, houses, offices and schools. There is still uncertainty about the level of concentrations that can produce specific health problems but it is accepted that even low concentrations of some pollutants that are ubiquitous can be very dangerous often causing undesired effects on health from sensory discomfort to serious consequences for physical conditions.

To improve this situation, new class of building materials can be a good tool to play an active role in environment remediation. At the beginning of the industrial productions, porcelain grés tiles were considered as just a technical material, aesthetically not very beautiful. Today thanks to new industrial production methods, both properties and beauty of these materials completely fit the market requests. In particular, the possibility to prepare slabs of large sizes is the new frontier of building materials.

However, it is time to go further the simple sustainable materials and to produce cements and tiles and in general building materials no longer inert but able to "work" to improve the well-being of people living in those spaces. In fact, besides the noteworthy architectural features, new surface properties can be introduced in the last generation of generating a new class of ecoactive materials. In particular, deposition of TiO<sub>2</sub> transforms the traditional ceramic surface into a photocatalytic eco-active material able to reduce polluting molecules present in air and water, to eliminate bacteria and to reduce the surface dirt thanks to the self-cleaning property, but keeping unchanged the standard requirements with respect to hardness, lack of porosity, vitrified surface, durability typical of a porcelain grés tiles.

The digital printing was exploited as a new tool to manufacture photocatalytic tiles even of very large size (150x300 cm) (DIGITALIFE project LIFE13 ENV/IT/000140 – award for best project of September 2017). The micro-TiO<sub>2</sub>-based ink preparation was carefully checked in order to have a stable and reproducible product bringing advantages in terms of costs and process sustainability. TiO<sub>2</sub> was therefore industrially formulated in a tailored ink, digitally printed at the tiles surface, fired in industrial kiln a 680°C and cleaned with a rotating wire brush to remove the TiO<sub>2</sub> weakly stuck at the tile surface. In the formulation, a commercial micro-TiO<sub>2</sub> (Kronos) was employed without using the traditional TiO<sub>2</sub> nanomaterials in powdery form. In fact, many recent papers are underlining the possible side effects on human health due to both use and exposure to nanoparticles. In fact, the ultra-small particles can penetrate inside human body from skin and nose especially when they are used in products like paints or simply cold-coated on materials surfaces for air purification and a loss of photoactive powder cannot be neglected.



Iris Ceramica/GranitiFiandre Group is the world leader in large porcelain stoneware slabs the answer to the world of architecture's demand, an area in which the designer expression needs a wide range of environmentally friendly options. The large dimension allows for great flexibility for designers and architects to create their projects by cutting and shaping the ceramic tiles so that they can create diverse and unique environments. The new slabs are produced thanks to the most innovative technologies in a wide range of surfaces that were created to expand the confines of the contemporary project, large flooring slabs that thanks to their 300x150 cm format, the largest ever created, allow for unexpected creative possibilities. The ability to produce and then photoactivate large slabs with an active coating allows more than just creating aesthetically pleasing environments but also healthy lifestyles.

The synergy between Active Clean Air & Antibacterial Ceramic™ and large slabs combines the advantages of both technologies in a new, high-performing material, which, applied to external façades, helps to obtain general benefits for the building both indoor and outdoor. The new technology is used to create a self-cleaning ceramic surface that, above all on the wall, prevents changes in color and helps to maintain the original appearance and brightness over time.

The antibacterial, anti-polluting and anti-odor action of Active also makes the large slabs even more effective in situations with particularly high requirements in terms of health and hygiene, such as clinics and hospitals, kindergartens and nursery schools, as well as spas or, more generally, to the places destined to accommodation and welfare. The new photocatalytic properties were verified in laboratory using NO<sub>x</sub> (generic term for the nitrogen oxides that are

considered by WHO the most relevant molecules for air pollution) and some VOCs to evaluate the good performance of the slabs to tackle the environmental pollution.

Volatile organic compounds (VOCs) include a variety of chemicals, which are often up to ten times higher indoors than outdoors, because they are released by a wide array of products of common use. For example, formaldehyde is one of the major ubiquitous pollutants. Even if in small amounts, we are often exposed to formaldehyde that has off-gassed from composite wood products usually used in buildings, resins, disinfectants and fixatives, or in several common products in which it is used as a preservative.

The photocatalytic Active slabs show excellent results in all the performed tests exhibiting a degradation of the selected molecules often close to 100% in a very short time.

Moreover, what about odors? Just think of entering in a nice restaurant and being invested by the smell of fried or of the food coming from the table near you. Even a simple odor molecule such as alpha-pinene, with its characteristic fragrance of pine is once again a VOC and it can be in many circumstances considered a bad smell and be unpleasant for many people. With all the odor molecules, Active tiles are able to purify air and allow living in a more pleasant environment.

In the same way, tests were performed on *E. Coli* and *Staphylococcus aureus* (even MRSA – i.e. resistant to antibiotics) to demonstrate the antibacterial efficiency of the ceramic surfaces. The antibacterial feature was also confirmed with a bacteria reduction of 99.99%, following the ISO 27447 procedure to perform the tests.

A frequent criticism of photocatalytic materials concerns their use only in the presence of sunlight or traditional artificial lamps, but not with the recent LED lights that have a type of radiation incompatible with the activation of traditional TiO<sub>2</sub>. All the photocatalytic processes are turned off inexorably when the material is illuminated by LED lights and, even more so, when in darkness. For this reason, researchers of Iris Ceramica/GranitiFiandre Group together with the University of Milan have developed an innovative method to modify chemically the commercial TiO<sub>2</sub>, used for the photocatalytic coating, doping it with metals (method under patent). In production soon, the new and innovative photoactivated slabs confirm the degradation of NO<sub>x</sub> and VOCs under the commercial LED lamps. Moreover, the presence of dopant metals allows the material to work as well as antibacterial in the dark, by eliminating one of the negative features of photocatalytic building materials that has so far limited its use on a large scale.

Active slabs are a new material in the ongoing search for a symbiosis between beauty and the pursuit of building healthy environments for people's wellbeing.