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VISAPPEAL – Multi-scale approach for understanding and controlling the visual appearance of materials in industry

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Visual appearance of materials, covering color and texture (gloss, sparkle, etc.) can be understood and managed better using a top-down and bottom-up multi-scale approach. This strategy is used in the automotive industry for the car body by different optical instruments for measuring color in different combinations of lighting and viewing, gloss, and other surface texture effects as sparkle (due to directional lighting) or graininess (with difusse lighting), etc. But, it can be progressively extended to other industries as cosmetics, plastics, coatings, printing inks, building materials, new materials, etc., using current or future industry and scientific standards proposed currenty for the automotive sector. Nowadays, many special-effect pigments, with goniochromatic or other functional effects, are extensively used in many industries for manufacturing attractive colored products. The light-matter-eye interaction is mainly responsible for these colorful effects in daily objects as cars, joys, cosmetic products, etc. However, the origin of this visual appearance is a complicated sinergy of variables and models from at nano/micro scale to (macro) optical behavior, including the visual assessment of the human observer (colorist, quality engineer, client, etc.). And, in all quality processess of visual validation of objects (cars, joys, etc.), the visual and instrumental correlation should be undestood and proactively managed for producing repeatable objects with the same visual attributes (color, gloss, sparkle, etc.). Spite of some important progresses in advanced optical instrumentation for measuring color, gloss, etc., this is not enough for new pigments, materials, etc., and in many times even it is not enough without running experiments of visual detection, scaling or grading, and discrimination, or visual tolerances. Therefore, the visual appearance of materials can be converted in this century into an excellent example of inter and multi-disciplinary science.

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Electromagnetic excitations in microcavities lattice containing ultracold quantum dots

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Photonic structures and metamaterials are in the focus of theoretical and experimental interdisciplinary studies, which span laser physics, condensed matter physics, nanotechnology, chemistry and information science. The important features of photonic band-gap structures under discussion are connected with 'slow' light, which is one of the promising fundamental physical phenomena that can be explored in the design of various quantum optical storage devices. In particular, the effective reduction of the group velocity demonstrated in the associated optical waveguide resonators. Based on the representations of the ideal photonic structures, the non-ideal systems of this class - polaritonic crystal, which is a set of spatially ordered microcavities containing ultracold atomic clusters, is considered. Moreover, the spatial distribution of cavities (microresonators) is translation invariant, and the atomic subsystem has randomly distributed defects: impurity atomic clusters (quantum dots) or a vacancies. Numerical modeling of dependence of the dispersion of polaritons in this imperfect lattice of associated microresonators on impurity concentration is completed. Using the virtual crystal approximation the analytical expressions for polaritonic frequencies, effective mass and group velocities, as a function of corresponding quantum dots and vacancies concentrations, is obtained. It turned out that even with a small number of vacancies in the lattice (one position for a thousand resonators) weight polaritons increases by three orders of magnitude. These results enable to extend the possibility of creating a new class of functional materials - polaritonic crystal systems.

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