PRESS RELEASE

QUANTUM MECHANICS AT THE SERVICE OF THE PRODUCTS AND PRODUCTION PROCESSES QUALITY

A study by researchers from Politecnico di Torino and INRiM, published in the prestigious journal Science Advances, has shown that, through optical measurements optimized thanks to quantum correlations, called 'entanglement', it will be possible to reduce errors in the verification of conformity of certain products and production processes.

Turin, 22nd December 2021 – In an article **published in the prestigious journal** Science Advances (DOI: 10.1126/sciadv.abm3093), researchers from **Politecnico di Torino and National Institute of Metrological Research (INRiM)** have proposed an innovative approach, based on quantum technologies, to **check if a production process conforms** to a reference or if it a "defective" one.

An effective monitoring of the production processes is fundamental both for the safety of the released products and the economic efficiency of the process itself. Conformity tests are often performed with measurements on a random subset of the final products.

Exactly in this scenario, the researchers have shown that **making use of quantum "*entangled*" light sources can notably reduce the probability of having classification errors** – *conform* or *defective* – at a fixed irradiated energy on the samples, improving substantially the efficiency of the monitoring. *Entanglement* (between two beams of photons) in quantum mechanics is the existence of a degree of correlation higher than what is possible in "classical" light sources (that is, they can be described in terms of classical physics).

The same article reports the experimental realization of what the Politecnico di Torino and INRiM's Researchers have called "***Quantum Conformance Test***". In short, one of two entangled beams of light interacts with the tested object while the other one is used to measure the light fluctuation with high precision. The experiment shows how the quantum conformance test can be realized with present technology available in

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laboratories, thus in perspective transportable toward practical applications in the near future.

Important examples are optical transmittance measurements and spectroscopy, useful for the characterization, for example, of chemical concentrations and biological samples. Since **each substance absorb light in a different way** for different optical frequencies (colors, in the visible spectrum), its concentration can be estimated by means of an optical transmissivity measurement, i.e., measuring the intensity before and after the test object. However, the production process is affected by statistical fluctuations so that the concentrations, and consequently the optical intensity transmitted, will be distributed around a reference value.

Intrinsic fluctuations in conventional light sources typically used for optical measurements, including lasers, reduce the accuracy in the characterization of the products. This limitation is particularly relevant in case of photosensitive samples, for which it is fundamental to use low-intensity light and to keep small the number of products tested over the whole production. In this situation, the effect of intensity fluctuations of the light source is amplified. The protocol, developed by the researchers and illustrated in the article, shows excellent prospects for reducing the margin of error in monitoring of this type.

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