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ABSTRACTS

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APPLICATION OF QUANTUM CASCADE LASER TO RAPID DETECTION OF FOOD ADULTERATION

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Human health is seriously endangered by economically motivated adulterations of foodstuffs, in general, and spices, in particular. Additional advances are needed in trustworthy techniques for the fast recognition of fraudulent ingredients in the supply chain. After more than a decade of application of laser photoacoustic spectroscopy (LPAS) to food fraud detection with CO2 lasers, the Diagnostic and Metrology Laboratory of ENEA realized a portable and easy system based on a quantum cascade laser. Saffron adulteration was used as a case study to evaluate its performances. Chemometrics tools as principal component analysis (PCA) and partial least squares regression (PLS) demonstrated that the instrument was able to sense in a few minutes two adulterants at concentrations of some percent.

P-5

INCREASING RADICAL DENSITY IN ATMOSPHERIC PRESSURE DISCHARGE BY BI-POLAR NANOSECOND HIGH VOLTAGE PULSES WITH MHZ REPETITION RATE IN BURST MODE

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In this work, a bi-polar nanosecond high voltage (HV) pulse generator with a maximum pulse repetition rate up to 1 MHz in burst mode and a peak voltage up to ± 15 kV is developed, based on full bridge converter using SiC MOSFET and pulse transformer.

With this HV source generating a burst of 20 HV pulses, atmospheric pressure plasma jet (APPJ) in Ar + 1%CH4 gas flow is formed. The absolute density of hydrogen radical at ground state is measured by the two photon absorption laser induced fluorescence (TALIF) method and a peak density more than 10^{15} cm^{-3} is obtained. Such high radical density is obtained after the impulse of about 10 HV pulses, and later on the hydrogen density reaches a quasi stable value while more HV pulses are applied. This accumulative behaviour of hydrogen radical is absolutely different from that of the optical emission from the excited hydrogen atom (H $n = 3 \rightarrow n = 2$, 656.3 nm), the latter of which decays rapidly after each HV pulse. The characteristic time for the decay of hydrogen radical during the afterglow period is on the order of tens of microsecond.

Based on the investigation in this work, it is proposed that nanosecond HV burst with a high pulse repetition rate is an efficient method to generate highly active non equilibrium atmospheric pressure discharge.

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TOWARDS CARBON-BASED ADVANCED 2D QUANTUM MATERIALS: STRUCTURE AND STRONG ELECTRONIC CORRELATIONS IN NANODIAMOND ISLANDS CONFINED BETWEEN TWO GRAPHENE SHEETS

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Based on direct space *ab initio* density functional theory electronic structure calculations, the structure and properties of nanodiamond islands confined between two graphene sheets was proposed

and theoretically explored. DFT simulations revealed that fusion of planar aromatic molecules with two graphene fragments may form both cubic and hexagonal NDI-c2Gs allotropes accompanied with formation of local sp^3 graphane islands in graphene sublattices. Upon estimation, the NDI-c2Gs formation energy (−0.54 eV/atom) falls between that of graphane and diamane. The low distortion energies which are smaller vdW interactions allow NDI-c2G lattices to be synthesized. It was found that in the vicinity of graphane island regions, graphene lattices are estimated to be either low-, or anti aromatic. Formation of NDI-c2Gs shrinks the HOMO-LUMO gap of graphene fragment up to 0.35 eV with frontier orbitals localized on both graphene flakes in the vicinity of diamond islands. The NDI-c2G regions can be considered as a pair of quantum dots isolated from each other by a NDI scattering center of 0.23 eV potential energy barrier. Using combined analysis of atomic and electronic structure of NDI regions it was shown that NDI-c2G should be considered as strongly-correlated quantum materials with great potential for advanced quantum applications.