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Zero-Emission Technologies Based on Discharge Produced Plasma

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Temperature and density of discharge produced plasma (DPP) extend extremely wide ranges. In addition, the plasmas can be categorized into thermal and non-thermal one according to their energy distribution. Therefore, DPP is expected to be applicable to many practical uses and R&D is in progress.

Using very short voltage pulses or dielectric barrier discharges, atmospheric pressure non-thermal plasmas, which are known to be abundant in reactive species, can be generated. Such plasma was used for ignition of internal combustion engines to increase the combustion efficiency. Applying several successive high voltage pulses with peak voltage of more than 20 kV and pulse width of less than a microsecond to premixed air/propane gas, stable ignition was achieved even at Air/Fuel ratio larger than stoichiometric one (lean burn), which leads to the decrease of CO_2 in the exhaust gas and thus contributes to the conservation of global environment.

The non-thermal plasma can be also used for sterilization of microorganisms by the dry process. Humid nitrogen remote plasma produced by dielectric barrier discharge revealed that it has ability to sterilize spore-forming bacteria (geobacillus stearothermophilus ATCC#7953) under appropriate condition, which is applicable to water purification etc. The D-value attained was several minutes under optimum condition and the major sterilization factor was attributed to peroxynitrite anion radical.

Inertial electrostatic confinement (IEC) fusion device is a compact and controllable neutron source, which has potential to be used for the production of short-lived radio isotope (RI) by nuclear transmutation. The produced RIs are used for positron emission tomography (PET) or single photon emission computed tomography. If neutron production rate would be much increased, the IEC device may also be used to produce high quality semiconductor material by the neutron transmutation doping.

Using pulsed power technology, high temperature and extremely dense plasma which emits short wavelength light can be generated by using z-pinch dynamics. Tin DPP extreme ultraviolet (EUV) at 13.5 nm is expected to be used as a light source for semiconductor lithography. Argon capillary DPP revealed it to be a soft x-ray laser (SXRL) at 46.9 nm and the R&D to shorten the wavelength of SXRL is in progress.

Several research topics will be introduced at the symposium.