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Application of Plasma Technologies for Air Pollution Control

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Several plasma technologies for air pollution control have been developed in KIMM (Korea Institute of Machinery & Materials) since middle of '90. These technologies are a plasma assisted burner for diesel after-treatment system, a plasma reactor for treating gases emitted from semi-conductor process, a combined process of plasma and catalyst for treating odors and VOCs, etc. At present, these technologies are intensively utilized in industries, and are shown in Fig. 1.

(a) (b) (c)

Fig. 1 Plasma technologies developed in KIMM, (a) plasma burner for after-treatment of diesel exhaust gases, (b) vacuum plasma reactor for treating semi-conductor process gases, (c) rotating arc plasma reactor for treating CF_4 emitted from etching process

One of the critical issues on after-treatment of diesel exhaust gases is that the temperatures of diesel exhaust gases under the specific driving conditions are too low to activate the catalysts in after-treatment system. So far, various technical approaches based non-thermal plasma have been intensively studied, since plasma chemistry induced by non-thermal plasma could be helpful to activate the diesel catalysts under the low temperature conditions (Lee et al. 2007). Although these non-thermal plasma technologies have shown successful test results, the technologies have not yet implemented in industry due to practical problems, such as cost, physical size of the devices, power consumption for generating plasma.

On the other hand, a plasma burner developed in KIMM is a kind of diesel burner to supply the supplementary heat to the diesel catalysts (Pyun et al. 2016), and is utilized in vehicles and marine ships. The majority of heat energy generated by the burner is converted from the chemical energy of diesel fuel. The role of the plasma in the burner is to stabilize the diesel flame in the diesel exhaust system in which flame could be extinguished due to high gas velocity and dynamically changing O_2 concentrations. Here, a rotating gliding arc plasma, which is a three dimensional version of a gliding arc plasma, is used, as shown in Fig. 2.

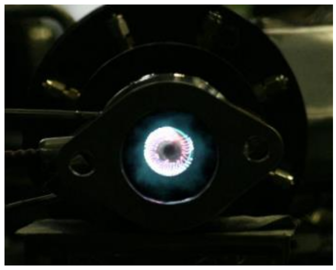

Fig. 2 Diesel flame and rotating arc plasma. The flame is located in the diesel exhaust pipe.

Another example of the industrial application of plasma technology developed in KIMM is a technology to treat etching gases such as CF_4, SF_6, NF_3 emitted from semi-conductor and display industries. Study of treating these global warming gases in KIMM has been conducted since early 2000 (Kim et al. 2005). In the earlier stages of the study, various type of plasma have been investigated, which are DBD, pulsed corona, vacuum plasma, atmospheric pressure arc plasma, etc.. Here, one of the important issues is the power consumption to decompose these relatively inert gases. After developing the plasma devices for treating the inert gases used in semi-conductor and display industries, currently the study is extended to conversion of methane and carbon dioxide that are another global warming gases. In this long-term investigation, numerous issues have been studied, which are plasma-catalyst interactions, different characteristics of plasma and thermal chemistry, role of carrier gases to be used for enhancing plasma chemistry, limitations of plasma chemistry for bulk chemistry, etc..

References

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