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Development of High Performance Magnetic Tunnel Junction (MTJ) Devices

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A magnetic tunnel junction (MTJ) device consisting of an ultra-thin insulating layer (called a tunneling barrier) sandwiched by two ferromagnetic electrodes is the key to developing non-volatile memory, MRAM (magnetoresistive random access memory). In the conventional type of MTJ devices, which use amorphous Al-O as the tunneling barrier, the fact that magnetoresistance is only about 70% at room temperature is an obstacle to large capacity MRAM. We developed a new type of MTJ devices using a tunneling barrier of high quality MgO and achieved a huge magnetoresistance ratio of 230% at room temperature. This is the world's highest performance in a MTJ device, at more than 3 times the level in conventional devices (see Fig. 1).

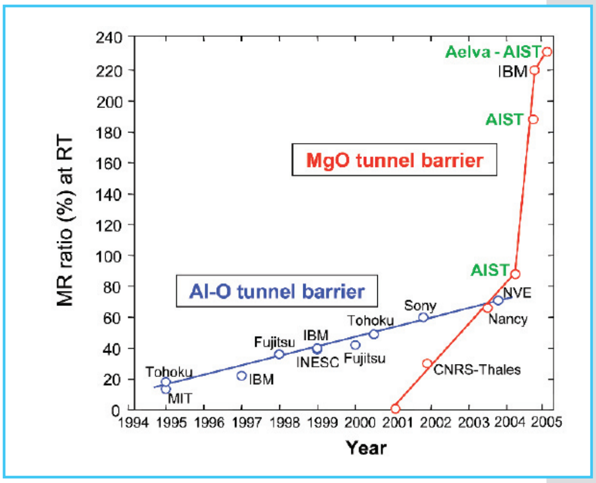

Fig. History of improvement in performance of MTJ devices (magnetoresistance (MR) ratio).

Nanotechnology , Materials & Manufacturing

Ceramic Reactor to Purge NOx by Using Power Derived from Exhaust Heat

Utilization of Electrochemical Device for Purging Vehicle Exhaust Gas

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The AMRI-AIST has been engaged in R&D of technology of electrochemical purging for NOx by using electrochemical reactor based on oxygen ion-conductive ceramics, and succeeded in decomposing NOx in oxygen-rich (3 % or more) gas mixture into N_2 and O_2 with an electrochemical reactor selectively and continuously, using very little electric power. The technology is attracting worldwide attention as zero emission purging, characterized by directly decomposing NOx by electrical means, in comparison to the conventional catalytic method with combined reductive agents. On the other hand, the electrochemical reactor system requires electric power to drive the reactor, in contrast to the catalyst method. As one of means to solve this problem, it has been attempted to provide electric power for driving the electrochemical reactor through power generation based on temperature difference between exhaust heat in waste gas and atmosphere by using thermoelectric conversion ceramics (Fig1).

It has been demonstrated that the thermoelectric conversion as high as 40 mW/cm2 is obtained for a temperature difference of 500 oC with a pair of thermoelectric ceramic devices. Moreover, the characterization of a compound module prepared by combining in series 37 pairs of 2× 2 x 20 mm rectangular solid modules has proved to generate 300 mW power (at 3.5 V) for around 650 ℃ temperature difference (with one end of junction heated to 800 ℃ while air-cooling the other, verifying the availability of the module as power supply for NOx purging electrochemical reactor.

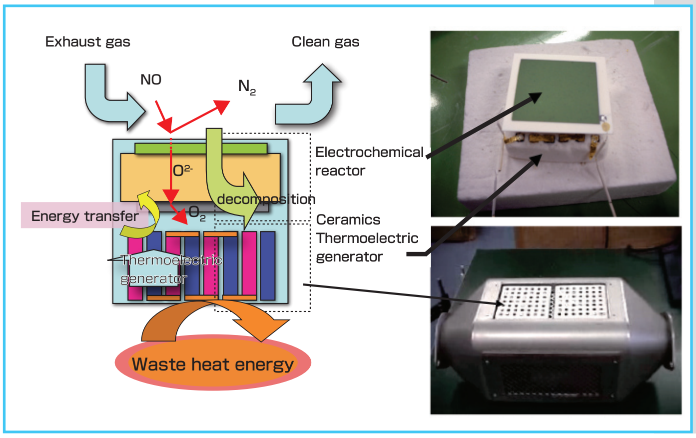

Fig.1 The principle of NO_x decomposition by electrochemical ceramic reactor using waste heat power generation.
Fig.2 NO_x decomposition electrochemical cell connected with oxide thermoelectric generator, and the example of NO_x decomposition reactor.