

Development of Paper Exhaust Catalyst Material for Emission Control in Small Internal Combustion Engines (2)

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ABSTRACT

We investigated the catalytic performance of a porous-structured paper coated with precious metals such as palladium(Pd) and others. A honeycomb-shaped paper catalyst was successfully produced by paper making techniques, which are often used in the friction material manufacturing process for clutch system and the following newly-developed molding process. As a new catalyst on the paper, Pd supported on Mn-substituted lanthanum hexaaluminate ($\text{LaMnAl}_{11}\text{O}_{19}$, magnetoplumbite, MPB) crystallites with appropriate surface area was prepared and the catalytic performance, such as exhaust purification ability, was assessed using a model gas containing HC(hydrocarbon), CO(carbon monoxide) and NO(nitrogen oxide) gas. The results showed that Pd/MPB did not deteriorate even after 180h aging at 1000°C. We concluded that the MPB has good potential as a catalyst component material for internal combustion engines because of the high thermal stability. As the coated paper canned in a stainless tube is so light-weighted that it would be suitable for a catalytic converter for small engines and general purpose engines including agricultural and garden equipment, and particularly hand tools.

INTRODUCTION

In recent years, the restrictions on the emissions from internal combustion engines have greatly increased not only in the developed countries but also developing countries due to the increase in environmental awareness. In response to these regulations, new catalysts including three-way catalyst have been developed and improved. The examples of the catalysts, of which performance is highly dependent on the type and the amount, include platinum(Pt), palladium(Pd), rhodium(Rh) and other precious metals. The expansion of the regulated

countries increased the demand of the precious metals for catalytic converters, resulting in the increase of the prices and further, their unstable supply. Thus, reducing the amount of precious metal used in the catalytic converters is vital. Here we propose a new structured catalyst with a unique porous structure made with papers. The details of paper exhaust catalyst and a new catalyst component, e.g. Pd/MPB, described in this paper.

EXPERIMENTAL

PAPER EXHAUST CATALYST MATERIAL

A porous sheet like material was produced using the paper making technique (Fig. 1).

After pulp beating in aqueous emulsion, ceramics fibers and powder were first added to the mix, and then dual polymer flocculants was added to bind the fiber and powder.

The flocculated materials in emulsion were filtered off and shaped into paper, which was then cut into tapes (Fig. 2).

The paper tape was molded to honeycomb shape and coated with ceramics contents (Fig. 3)

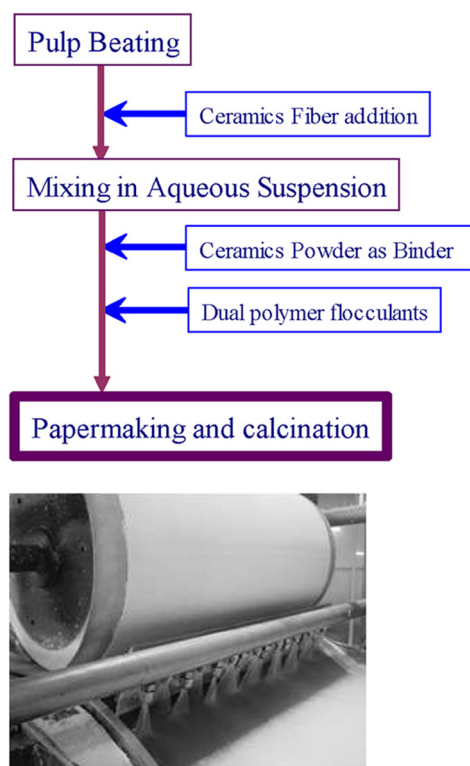


Fig. 1. Paper making processes



Fig. 2. Slitted paper

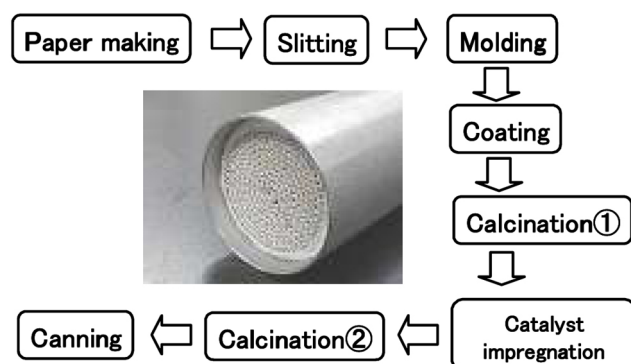


Fig. 3. Manufacturing process for precious metal loaded on paper honeycomb

NEW CATALYST

We considered Mn-substituted lanthanum hexa-aluminate ($\text{LaMnAl}_{11}\text{O}_{19}$, MPB) crystallites with appropriate surface area as a support material for Pd synthesized using pore-filling method. As a starting material, commercially available porous aluminum oxide with the aqueous solution of Mn and La ion (Fig. 4). After drying and calcining for 60h at 1000°C , XRD (X-ray Diffraction) measurement of the calcined sample confirmed that the crystallites was MPB, i.e. magnetoplumbite crystal structure (Fig. 5).

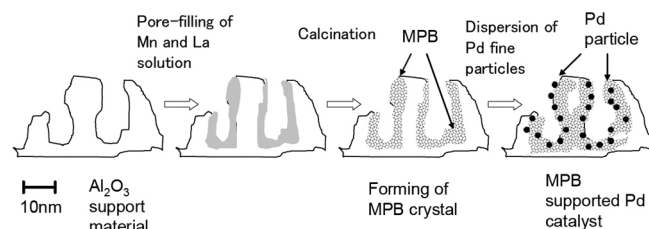


Fig. 4. The image of procedures of pore-filling method for Pd dispersed $\text{LaMnAl}_{11}\text{O}_{19}$ (MPB) support

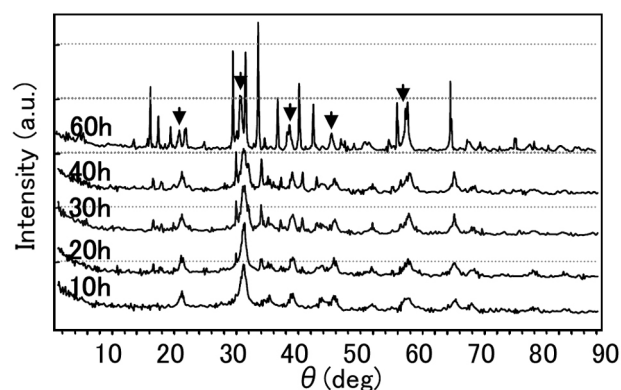


Fig. 5. XRD patterns of the supporting material $\text{LaMnAl}_{11}\text{O}_{19}$ (MPB) for each aging time at 1000°C

HONEYCOMB SHAPING AND CANNING

Corrugate processing (wave type molding) was used to mold the previously described paper tape into the shape of honeycomb. Wave type processing of paper was well performed and it was adhered to the unshaped flat paper as shown in Fig. 6. The honeycomb shape was formed by winding the paper into a roll (Fig. 7).