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Properties of Porous Silicon Nitride Bonded-Silicon Carbide Ceramics For Diesel Particle Filter

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Abstract- Diesel engines have been preferable engines for heavy, medium and light duty vehicle applications due to their superior performance and fuel economy. However, concerns with their emissions, which are highly toxic air pollutants, put some limitations to their widespread use especially in urban transport applications. Recent legislations for vehicle homologation which are implemented mainly in USA and EU, enforce installation of highly sophisticated exhaust gas after-treatment system to diesel engines. PM emissions are the inevitable combustion products due to the nature of diesel engine combustion and are mainly composed of carbon, hydrocarbons and inorganics. They are in the size range from 20 to 200 nm and diesel particle filter (DPF) has been the most effective solution to minimize them for the last decade as it can reduce PM's with efficiency over 90%. On the other hand, a DPF may have negative impacts on the engine performance and fuel economy if the exhaust back pressure, due to the DPF loading, increases to unacceptable levels. Therefore, developing an efficient DPF requires innovative design of filter microstructure as DPF efficiency and the exhaust back pressure typically have a direct relationship. Consequently, it is difficult to achieve simultaneous better values of the pressure drop and filtering yield.

In this study, silicon nitride bonded-silicon carbide ceramics was developed by using unique compositional design to obtain rod-like crystals on the porous structure in order to increase filtration efficiency. The influence of starting particle sizes (SiC and Si_3N_4) on the microstructural development was investigated. The sintering was carried out at atmosphere controlled high temperature furnace under flowing nitrogen gas. Microstructural investigations were performed by FEG-SEM. The phase analysis was done by XRD equipment. Porosity content and pore size were determined by using Archimedes principle and mercury porosimetry, respectively. The results showed that desired porosity level for DPFs was obtained. The rod-like crystal growth was achieved but does not show homogenous distribution.

Keywords- silicon carbide, silicon nitride, diesel particle filter, rod-like crystal, filtration efficiency