

Aerogel: Future Material of Automobile Industry

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Abstract- Aerogel is the world's lightest solid, containing 99.8% air. Aerogel is a man-made solid with high porosity (between 90 to 99.8+% porosity), extremely low density, and very low thermal conductivity. Due to the porous structure of aerogel. It acts as a good thermal insulator and an acoustic insulator. It has the lowest refractive index and dielectric constant of all the solid materials. Samuel Stephens Kistler is the man behind the creation of aerogel in 1931. He had a bet with Charles Learned over who could replace the liquid component in jellies with gas without causing shrinkage. These surprising properties of an aerogel open a new scope of application in a wide range of technological areas. This paper provides information and the future scope of aerogels in the automobile sector.

Keywords- Aerogels, Automobile, Thermal Insulator, Acoustic Insulator, Interior components of Vehicle

1. INTRODUCTION

Automobile Sector is growing rapidly. It is converting from internal combustion (IC) engine vehicles to electric vehicles for better efficiency and performance. In the past, automobile manufacturers used to focus on only one of the categories of vehicles i.e. performance, efficiency, safety, or comfort. With the growing competition, they are focusing on all these aspects. They are trying to achieve all these features in one vehicle.

Aerogel fulfills all these aspects. Aerogel is the ultra-light synthetic solid foam that is composed of a network of interconnected nanostructures, this results in a solid with extremely low thermal conductivity and low density. Since it has low thermal conductivity it can be used as a thermal insulator for body panels and windows along with acoustic insulation that is much better than a typical acoustic insulator. The anti-bacterial and light interior of a vehicle can be made with the help of aerogel. Thus providing all necessary functions to achieve the goal of making one of the best vehicles.

2. AEROGEL

Aerogel is an ultralight synthetic porous material that is derived from a gel, in which gas replaces the liquid component of the gel. The term aerogel refers to a geometry that a substance can take on, rather than to a particular substance. Aerogels are known for the class of structures i.e. having low density, open-cell structures, large surface areas, and nanometer-scale pore sizes. Aerogel material is made up of 99.8% air. It has a porous solid structure that contains air pockets, with the air pockets occupying the majority of space within the material.

Aerogels have a thermal conductivity smaller than, the gas they contain. Because of the Knudsen effect, which states that there is a reduction of thermal conductivity in gases when the size of the pores encompassing the gas becomes comparable to the mean free path. Effectively, the cavities in an aerogel restrict the movement of the gas particles, thus, decreasing the thermal conductivity along with thermal convection. Aerogels can be made from different materials like silica, carbon, metal oxides, etc.


Fig 1: Silica Aerogel

Fig 2: Pore Structure of Silica Aerogel [9]

3. APPLICATIONS

3.1 Thermal insulator

Thermal energy is transmitted through three types of methods i.e. conduction (through solids) convection (through fluids) and radiation (through electromagnetic waves) Aerogels are good thermal insulators because they are mostly composed of gases (which are very poor conductors of heat) and three-dimensional highly porous structure. (Which prevents net gas movement).

There are various heat-sensitive components of a vehicle that are subjected to high temperatures and must be protected, conventional insulation undesirably adds weight to the vehicle Conventional types of insulation, such as glass-filled foams, fibers, etc can tolerate high temperatures but have a relatively low capacity for insulation. For such materials, to provide effective thermal management the thickness of the insulation must be increased. Since there may be little or no available space to accommodate the additional heat, a different type of insulation material to provide effective heat insulation is needed. Aerogel materials can be used for thermal insulation as it consumes minimal space and weight in the vehicle. Aerogel materials are known to possess about two to six times the thermal resistance of other common types of insulation and thus are ideally suited for use in thermal management systems. Aerogels can increase effective thermal insulation without substantially increasing the thickness of the insulation or adding additional weight. Aerogel can be used with various vehicle components like a convertible top, electronic parts, windshield, body panels, windows, between engine passenger cabin (in case of IC engine), between floor and batteries(in case of an electric vehicle), between cells in a battery of EV to prevent cell to cell thermal runaway.

3.2 Acoustic insulator

The human audible sound range is between 20 to 20,000 Hz. While driving a car, noise levels are produced in a vehicle that is outside the human audible range which could lead to high-stress levels. To solve this issue, sound insulation materials like asphalt, butyl rubber, etc are used which increases the weight of the car for better sound insulation. Aerogels are much better acoustic insulator as compared to typical insulator as it is much lighter and provide much better sound isolation.

Sound insulation in aerogel depends on aerogel density, size of pores, and the method of preparation. There is a reduction in the amplitude and velocity of the sound as the sound wave passes through aerogel. It is observed that the sound speed can be as low as 100 m/s as compared with 332 m/s in the air at 0°C.with further modification in structure sound insulation can be up to 1000 times better than a conventional acoustic insulator.

3.3 Interior Components

With the advancement in the field of aerogel material, high-strength machinable aerogel material is developed that has the strength and durability of plastic but is three times lighter. The plastic used in vehicles like in dashboard, cup holders, etc can be replaced by aerogel material, thus improving efficiency and performance. When Nanoporous silica aerogels were synthesized via sol-gel polymerization of tetraethyl orthosilicate and hydrophobized using trimethylsilyl chloride It showed antibacterial properties[8]. This property can be used in seats, steering wheel, etc.

4. CONCLUSION

Aerogels have very unique and interesting properties. This paper tells the future scope of aerogels in the automobile sector. Properties of aerogels like thermal insulation, acoustic insulation, etc. can open new ways of improvement and advancement in the automobile industry.

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