



Non-covalent interactions between fumed silica and polymer to control key properties of reinforced silicone elastomers

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Silicone elastomers are widely used materials due to their unique combination of properties, such as high elasticity, temperature stability, biocompatibility, and resistance to various chemicals. However, controlling the properties of silicone elastomers can be challenging, especially when it comes to optimizing their mechanical and rheological behavior. Fumed silica particles such as AEROSIL® have been shown to be effective reinforcement fillers in controlling key properties of silicone elastomers, such as viscosity, modulus, and tear strength.

Fumed silica is a highly pure, amorphous form of silica that is produced by vaporizing e.g. tetrachlorosilane in a high-temperature flame. This process results in a highly structured particle with a high surface area, making it an ideal candidate for reinforcing silicone elastomers. When fumed silica is added to a silicone elastomer, it forms a network of interconnected particles and strongly interacts by non-covalent forces to the silicone polymer chains significantly improving the mechanical properties of the elastomer. The interaction between polymer chains and silica aggregates depends on the specific surface area, particle morphology and surface chemistry of the filler.

In this presentation, we will discuss how physical interactions between the polymer and the filler particles affect the degree of crosslinking in the polymer network. On one hand, the chemical crosslinking in silicone elastomers occurs through a reaction between the polymer chains and a crosslinking agent. The filler particles can act as physical barriers to the crosslinking reaction, reducing the degree of chemical crosslinking and thus decreasing the network density of the material. On the other hand, the physical interactions between the polymer and the filler particles can affect the elasticity of the material. If the filler particles are strongly bonded to the polymer matrix, they can restrict the mobility of the polymer chains, resulting in a stiffer elastomer. This can increase the compression set of the material, making it more difficult for it to recover its original shape after being compressed.

Therefore, it is important to carefully choose the suitable type and amount of silica filler incorporated into the silicone elastomer to balance the improvement in mechanical properties with the effects on network density and compression set. By optimizing the physical polymer-filler interactions, it is possible to create silicone elastomers with both improved mechanical properties and good resistance to compression set. In conclusion, fumed silica fillers are a versatile tool for controlling the key properties of silicone elastomers. By adjusting the structure and surface treatment of the fumed silica, it is possible to optimize the properties of silicones opening the doors towards a wide range of applications.

References

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