High quality carbon black to surpass traditional solution for HV semicons ?

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The efficiency of the semiconductive layer depends on its electrical conductivity that is guaranteed by the presence of conductive carbon black in the semicon formulation. It has been proven that electrical aging mechanisms are directly linked to semicon protrusion as they locally increase the electrical field.

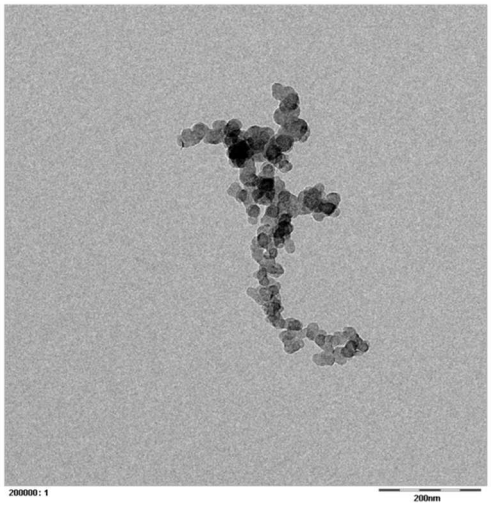

Fig. 1: Conductive carbon black TEM picture

As carbon black is an essential constituent of semicon compound, its quality affects the semicon performance and hence the final cable lifetime. Any impurities present in the raw material such as grit (e.g. large amorphous carbon particles remaining from production) or carbon black agglomerates not to mention ionic content are detrimental for the final application.

While the level of grits is an intrinsic characteristic of the carbon black used and will remain in the final compound, the carbon black agglomerates must be dispersed and distributed by proper processing although only specifically designed carbon blacks can achieve high level of dispersion. For example low surface area is linked to large primary particles and is known to favor dispersion thanks to the better wetting of the aggregates by the molten polymer. Also the high carbon black structure (e.g. a high degree of branching of the carbon black aggregates) is known to ease dispersion and distribution thanks to the lower inter-aggregate interactions and that is why low surface area high structure carbon black are the only choice for HV and EHV semicon compounds. Although surface smoothness is the primary requisite for a good semiconductive compound, other characteristics are essential for a good quality HV cable. A proper level of volume resistivity at the operating cable temperature and its stability after thermal cycling is also crucial for good cable manufacturing. Proper level of conductivity is achieved only at specific carbon black loading that is in turn dependent mainly on the level of branching or “structure” of the carbon black aggregates and the intrinsic carbon black conductivity.

In this article we will show that an easy-dispersible, clean carbon black, with higher intrinsic conductivity can be used at lower loadings than the commonly used carbon black in HV semicons. By direct comparison we will show the benefits of using lower amount of the new carbon black, especially the lower viscosity and the longer scorch time of the compound while keeping excellent surface smoothness and stable conductivity. Carbon black ionic impurities and moisture uptake that are transmitted to the final compound and can initiate electrical treeing will also be discussed in detail.