IN-MOULD MULTIFUNCTIONAL COATINGS WITH GRAPHENE NANOCOMPOSITES

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Two-dimensional, single layers of graphite, called graphene, have been studied for over 40 years now, due to its impressive properties such as high electrical conductivity, high thermal stability and mechanical strength.[1, 2] Additionally these two dimensional graphene sheets act as barrier and reduce gas permeability.[3] Thus applications of graphene in coatings where its geometry can be best utilized are most suitable.

The aim of the work was the straightforward production of composites for industrial coating purposes with focus to enhance the electrical conductivity and increase mechanical and barrier properties of coating polymers. Therefore, composites of a high performance thermoplastic and graphene in different concentrations were produced by extrusion. Due to the high viscosity of the extrudate, manufacturing of films by film extrusion was not feasible, thus a post processing consisting of pelletising, cryomilling and film pressing via high temperature press was necessary. The shortcut to press the pellets directly and try to avoid the milling step resulted in inhomogeneous films. The set-up for the high temperature pressing is shown in Figure 1. The composite pellets respectively the powder were placed in the middle of the metal plate, let melt and finally a pressure of 3 t applied.

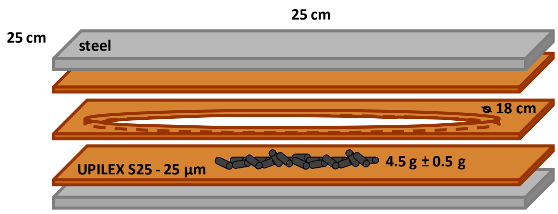

Figure 1: Set-up for high temperature pressing. The black composite pellets respectively powder were pressed between 2 steel plates and ultra heat-resistant UPILEX film

For the pressed nanocomposite powders with different graphene content (2.5, 5 and 10 wt%) segregation was observed (Figure 2). Visually it seems like the "graphene content" stays where the powder was placed before heating and the molten PES "squeezes out". 4 point probe and TGA analysis will provide more information about that.

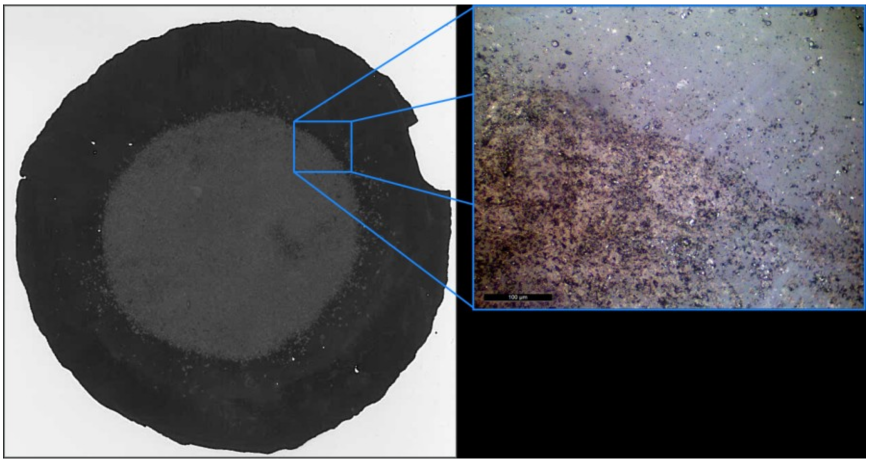

Figure 2: Scan respectively optical microscope image of a section (blue) of the visible gradient of the PES/graphene composite with 5 wt% graphene content

The differences of in-bulk conductivity after extrusion and conductivity in films with aligned graphene sheets were evaluated by 2 point probe and 4 point probe electrical conductivity measurements. For the 2 point probe measurements the extruded polymer string was cut in pieces and conductivity measured with the set-up shown in Figure 3. The non loaded PES as well as the nanocomposites showed no conductivity. Even for the high loading with 10 wt% graphene no percolating network was achieved (~ 5.5 x 10^{-8} S m^{-1}).

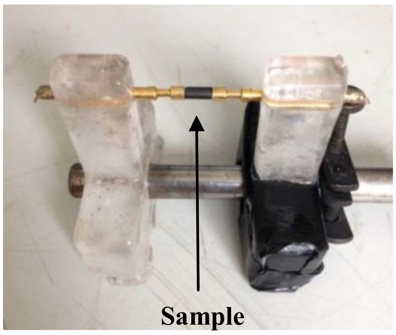

Figure 3: 2 point probe set-up

The production of homogeneous films is the key point of the whole work. New solution approaches were tried to overcome the existing issues and reach the objective. Stay tuned!

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