

Preface

Textile materials are materials for the daily use. Everyone wears clothes, uses linen and every apartment is equipped with curtains and carpets. For thousands of years we use our clothes to protect us against the weather, as well as to keep us warm and dry. At the same time, textiles are important for fashion reasons. Carpets separate our feet from the cold floor, they absorb the noise if one walks over the floor and they embellish the rooms. Since these applications of textiles are very old one can state that the production of textile is a very traditional business. Besides the traditional textile applications the area of technical textiles is very important and a growing part of the textile industry. Comparable with the conventional textiles many of these technical textiles can be found everywhere and everybody uses such technical textiles although not everybody notices them. Some examples are the conveyor belt at the cash desk in the supermarket, the safety belt and the airbags in the cars or the roofs of the modern sport arenas. Further examples are enumerated to give an idea in which products technical textiles are applied:

- in building trade textiles are used to reinforce concrete
- bullet-proof vests protect against weapons
- modern architecture uses textile materials in building trade
- many components in cars, aircraft and even space vehicles are reinforced with fabrics
- in medical applications textiles are used, for example, as implant material
- ...

Textile materials offer a number of advantages that make them essential for clothes as well as for technical textiles. Fabrics can be draped in many different forms – if needed thousands of times, they can be prepared to be flexible as well as inflexible, they show a certain permeability for air, vapour and liquids and textiles combine an enormous stability (especially tensile strength) with comparatively low weight. Fabrics can be produced with large surfaces and are simultaneously comparatively light in weight. In many cases textile approaches therefore offer solutions favourable in price and performance.

Up to the beginning of the 20th century textile materials based either on animal (e.g. wool, silk) or plant fibres (e.g. cotton, bast). With the rise of synthetic fibres these became ever more important for the textile industry. In the decades after the synthetic fibre materials were invented polymer scientists developed fibre polymers for a lot of applications. During this time the idea was to produce a certain polymer for certain applications, but market economy lead to a narrowing of the assortment of fibre polymers available. No new fibre polymer was introduced in the market successfully for many years, and many of the fibre polymers lost their commercial relevance. Today approximately 50 % of the textiles are made of cotton and the rest is mainly based on polyester and polyamines plus some minor materials [Schenek (2001); Koslowski (1997)]. In 2006 nearly 80 % of the textile fibres produced in the world were polyester and cotton [www.ivc-ev.de]. Some studies say that in several years the only fibre materials of importance will be based on cotton or polyester (which means poly(ethylene terephthalate), the synonym for polyester in textile industry) and the polyolefines (polypropylene and possibly polyethylene). At the same time as this reduction of the variety of fibre polymers that are commercially available the number of applications for textile materials increases impressively. Especially the market for technical textiles shows high rates of economic growth. The demand for new materials or for materials with new or additional properties is immense. Against the background of facts mentioned before this means that these new materials have to be developed dealing with the fibre

polymers available. Due to this reason the surface modification of fibre materials is an important topic of textile research worldwide.

The modification of textile fibres is carried out by commonly used chemical or electro-chemical application methods. Many of the classical textile finishing techniques (e.g. hydrophobization, easy-care finishing) that are already used since decades are amongst these methods. Dyestuffs, polymers or monomers are applied to the fibre material and are deposited either permanent or often only temporarily. Modern techniques are applied more and more parallel to these. One of these modern techniques is, for instance, the treatment with corona or plasma. Corona treatments allow one to modify the surface of the polymeric material either by surface etching or by introducing oxygen-rich groups onto the polymer surface. Plasma treatment can add a huge number of functional groups to the polymer surface, depending on the process gases in the plasma chamber. The literature reports, for example, the deposition of fluorine rich surfaces, leading to highly repellent fabrics [Bahners et al. (2001)]. The plasma techniques offer far reaching possibilities, but the technical effort is comparatively high due to the fact that the processes often have to be carried out under reduced pressure or at least under exclusion of oxygen. Besides plasma treatment electron beam technologies as well as different photonic technologies (UV-, laser treatment) [Praschak et al. (1998) & (2000)] are applied to achieve certain functionality.

One of the different new approaches and possibly one of the most promising for surface modification of textile materials – and certainly not only of textile materials – is the sol-gel technology which was probably one of the most important developments in material science during the last decades. The sol-gel technique offers far reaching possibilities for creating new surface properties. In the literature a tremendous amount of functionalities can be found that have been achieved by application of sol-gel coatings. Sol-gel technology promises the possibility to tailor surface properties to a certain extent, and to combine different functionalities in a single material. At the same time the application of sols can be carried out with techniques commonly used in the textile

industry. Finishing of textiles can, for example, be carried out in a simple dip or padding process followed by a thermal treatment in a stenter frame.

In this book we concentrate on the use of so-called nanosols for modification of textile materials. Nanosols are colloidal solutions of nanosized metal oxide particles in aqueous or organic solvents or mixtures of both. Due to the high surface area of the small particles the nanosols are metastable. During a coating process the particles will aggregate as well as condense, initiated by evaporation of the solvent and, for instance, by thermal treatment. These processes mostly result in dense three-dimensional metal oxide networks. The basic inorganic nanosols used for such coating procedures can be modified over a wide range, leading to coatings which exhibit many new functionalities. Nanosol coatings can be easily applied to a huge number of materials such as glass, paper, wood, metals, synthetic polymers, natural fibre material and thus also to textiles. In comparison with many other materials textiles products combine, for example, high flexibility and usually low thermal resistance. The conditions for the treatment and the composition of the nanosols have therefore to be adapted to the particular demands of textiles.

The intention of the authors was not to write a book explaining the principles of sol-gel technique or of nanosols. Concerning this a number of excellent books are available, most of them will be cited frequently in this book. This work gives an overview of possible applications of nanosols for the modification of textiles.

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