PVC coatings in a car interior: from instrument panel, door and side trim to seat coverings and visors (figure: Benecke-Kaliko)

Polyvinylchloride (PVC)

Back to Square One. Growth in the worldwide PVC market has occurred primarily in China. In contrast, European demand in 2012 was below that in the crisis year 2009. PVC specialties have shown better growth than commodities. Only moderate global growth is expected in the coming years. Consolidation of the European PVC industry continues.

In 2012, worldwide production capacity for PVC was 54 million t (source: IHS), an increase of 9 million t since 2009. Most of this capacity increase again occurred in China, which now has about 44 % of the world's capacity. Its current capacity of 24 million t far exceeds the Chinese domestic demand of 14 million t. Because of the increasing costs for energy and raw materials in recent years, the coal-based carbide route for producing the PVC precursor VCM that dominated in China has become less competitive. The greater environmental impact associated with this technology is another aspect. In this regard, this cloud appears to have a silver lining in China: the CTO (Coal to Olefins) process which, according to Chinese media, is about to achieve an industrial-scale breakthrough – this is the hope – could address this environmental problem while at the same time reducing manufacturing costs. In a best case scenario for China, manufacturing costs would then lie below those for the naphtha/ethylene route used widely in Europe. It can be assumed, however, that a CTO process will not undercut the low costs associated with the shale gas-based production in North America (see below).

In North America, which has 15 % of worldwide PVC capacity, plant utilization has almost reached the pre-crisis level again. The reason for this can be found less in improved regional demand for PVC, but instead in the increased export volume, since in 2012 more than one-third of North American production was exported. In 2007/2008, exports accounted for less than 10 %. The primary reason for this development can be found in the cost benefits along the value-added production chain for PVC that resulted from the shale gas boom. Exploitation of this resource is already leading to talk of a re-industrialization of the USA and expansion of the domestic petrochemical industry. As a consequence, some expansions in PVC capacity are being planned for after 2014.

"One man's sorrow is another man's joy" - could describe the current and expected realignment of the world's PVC producers. The exploitation of shale gas reserves in the USA means not only considerably lower-cost ethylene from cracking of ethane, but also considerable cost benefits from gas-based electricity generation, which in turn lowers the production costs for chlorine as a PVC precursor by means of chlor-alkali electrolysis. Significant cost benefits for manufacturing PVC in North America are the result – creating a serious competitive disadvantage and challenge especially for European →

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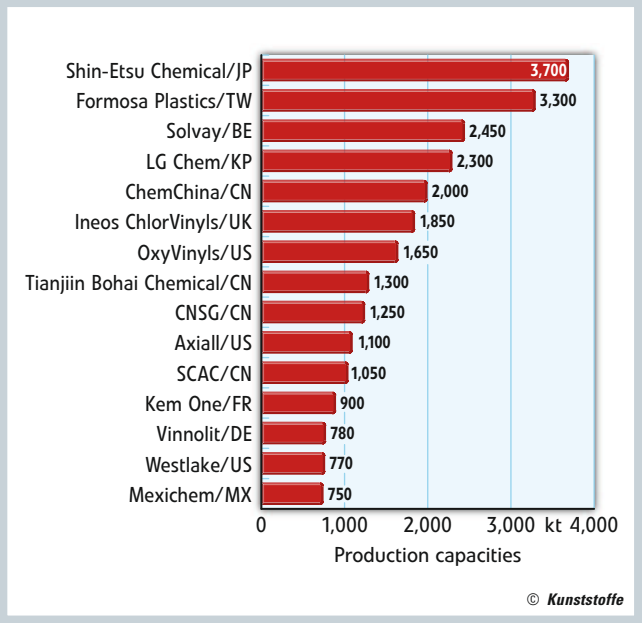

Fig. 1. Production capacities of the world's largest producers (as of 6/2013) (source: Vinnolit)

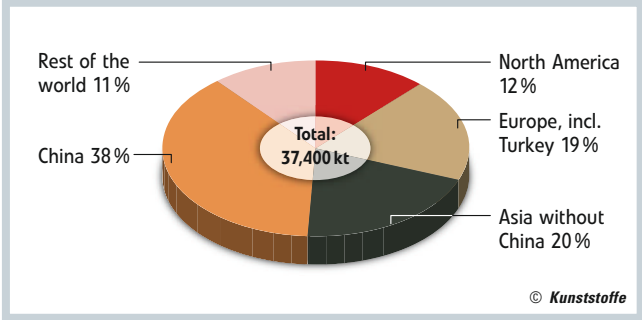

Fig. 2. Worldwide PVC consumption in 2012, broken down by region (overall 37,4 million t) (source: IHS/Vinnolit)

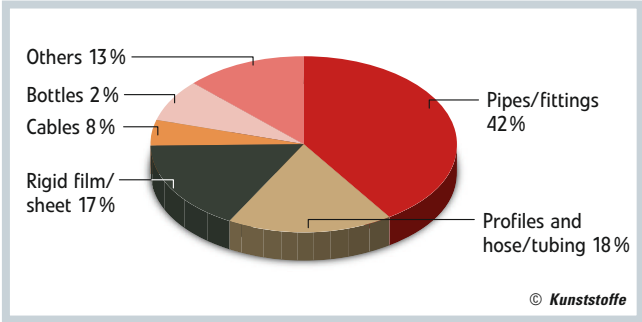

Fig. 3. PVC applications around the world in 2012 (source: IHS)

manufacturers, who also account for about 15 % of worldwide PVC capacity.

Figure 1 shows the production capacities of the world's largest producers (as of June 2013). Several changes also occurred here in recent years: Following acquisition of the PVC line of Limburgse Vinyl Maatschappijin (LVM), Tessenderlo, Netherlands, by Ineos ChlorVinyls Ltd., Rolle, Switzerland, in 2011, Ineos Group Holdings PLC, Rolle, and OxyVinyls Corp., Dallas, TX/USA, exchanged positions in the ranking of the largest producers. After merging with the commodity chemicals business of PPG industries, Pittsburgh, USA, Georgia Gulf Corp., Atlanta, GA/USA, has been operating since 2013 under the new name Axiall Corp., Atlanta, GA/USA. After being sold to the Klesch Group, Geneva, Switzerland, the PVC business of Arkema SA, Colombes, has been operating under the name Kem One, Lyon, France, since 2013. The large Chinese competitors have climbed in the global ranking. The picture is different, on the other hand, for PVC specialties intended for paste processing – here, the Europeans as represented by Vinnolit GmbH & Co. KG, Ismaning, Germany, Solvin/ Solvay Plastics, Brussels, Belgium, and Vestolit GmbH & Co. KG, Marl, Germany, hold the top three places in the world.

Consolidation in the industry continues: Ineos ChlorVinyls and Solvay, previously in sixth place and third place, respectively, in the worldwide ranking, have – pending approval by government agencies – announced the merger of major portions of their PVC business for the end of 2013. Such a merger would abruptly catapult the new company to 2nd place behind Shin-Etsu Chemical, Tokyo, Japan, and ahead of Formosa Plastics Group, Taipei, Taiwan.

Consumption and Export

With 37.4 million t in 2012, PVC is in third place behind polyolefins in terms of global plastics consumption. Average annual market growth (CAGR) of 4.9 % in the period from 2009 to 2012 occurred largely in China, the largest single market (with 14 million t), which grew by 3.7 million t from 2009 to 2012. At same time, China still imports over 1 million t of PVC per year; the projected transition to a net exporter has not yet taken place. A breakdown by region is given in **Figure 2.**

After the record year of 2007, and following the worst of the financial and economic crisis in 2009, the European PVC market has not yet rebounded to the pre-crisis level yet. The drop in demand in 2009 versus 2007, especially in the European Economic Area (EEA = EU + Iceland, Liechtenstein and Norway) was an inconceivable 24 %. After an initial recovery of about 5 % in 2010, the PVC market in this region exhibited a decrease of 4 % per year on average. Demand in the EEA in 2012 was even lower than in the crisis year of 2009.

Worldwide demand for PVC is determined largely by construction activity. The most important applications globally are pipes and fittings (42 %), profiles and hose/tubing (18 %), rigid film and

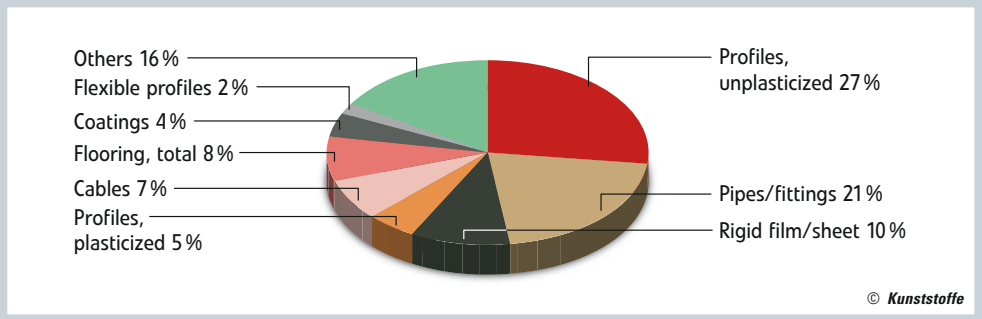

Fig. 4. PVC applications in Europe in 2012 (source: Vinnolit)

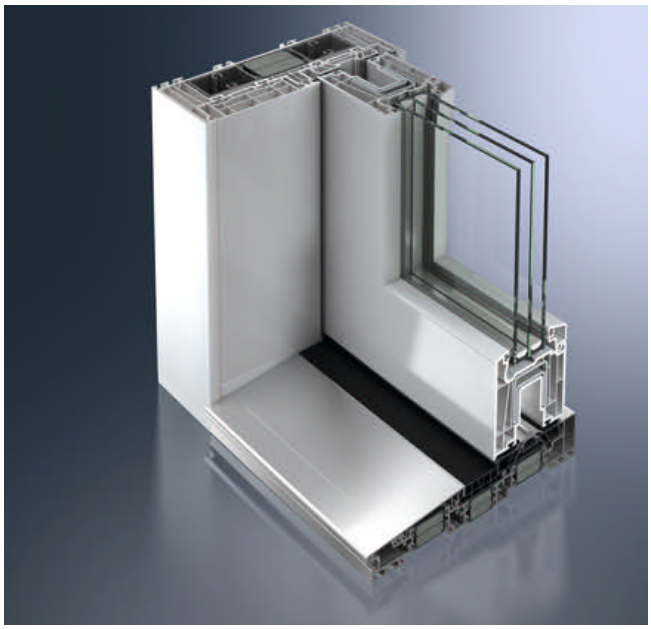

Fig. 5. Energy-saving PVC window profiles – the no. 1 PVC application in Europe (figure: Schüco)

sheet (17 %) as well as cable (8 %) **(Fig. 3)**. Given that construction activity in the Euro zone is far below historic levels and has still not reached the pre-crisis level in the USA despite considerable improvements, global PVC growth in 2012 has been driven primarily by the still-intense construction activity in the BRIC states (Brazil, Russia, India, China).

Price Development and Trends

Since the beginning of 2009, capacity utilization among manufacturers in the EEA has been around 75 %. PVC overcapacity here still exceeds 1 million t. Producers are attempting to boost utilization by increasing exports.

As the PVC price is determined primarily by supply and demand, and with the PVC market in the EEA characterized by overcapacity and low capacity utilization since 2009, it is not surprising that the price and profitability level has dropped to a certain minimum. It should be noted that the price level in recent years has changed largely in response to cost effects associated with the most important raw materials – above all, ethylene. On this basis, business with standard S-PVC cannot be profitable for the producers.

A slightly better development was observed briefly for PVC specialties. The demand for paste PVC rebounded from the crisis very dynamically in 2010 and encountered an availability bottleneck at the end of 2010 that supported a higher price level worldwide until this development ebbed in the course of 2011, resulting in a largely balanced market for paste PVC since then.

The slow yet continuous and uninterrupted increase in the volume of rigid PVC applications that lasted until the crisis year of 2009 did not continue: because of the relative weakness in large construction applications, the volume of flexible applications in Europe has grown from just under 31 to 33 % since then. Nevertheless, unplasticized profiles, pipe/fittings and rigid film/sheet still remain the largest applications. **Figure 4** shows PVC applications by region in Europe **(Title figure, Figs. 5 and 6)**.

Worldwide, almost 6 million t of plasticizers are →

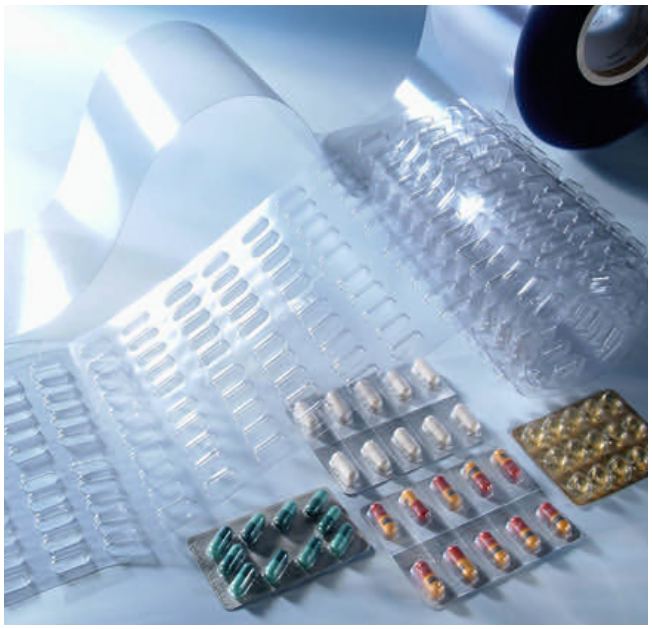

Fig. 6. In 2012, rigid PVC film (here, pharmaceutical film) held third place in the ranking of PVC applications (figure: Bilcare)

used annually, with 1 million t of them in Europe (source: ECPI). Replacement of DEHP (di-2-ethyl-hexylphthalate) with high-molecular-weight phthalate plasticizers having 7 to 13 carbon atoms in the main chain, e.g. DINP (diisononylphthalate) and DIDP (diisodecylphthalate), has continued in Europe. As a result, DEHP usage in 2011 accounted for only about 10 %, while 80 % of the plasticizer used in Europe were high-molecular-wait phthalate plasticizers (DINP/DIDP/DPHP). The two most frequently used high-molecular-weight phthalates – DINP and DIDP – underwent extensive evaluation by European agencies. The result: neither has been classified as a health or environmental hazard. They will thus be able to retain their position as standard plasticizers in the future as well. With a proportion of 10 %, a number of alternatives to the phthalates have gained acceptance in the market. In addition to use in sensitive applications such as children's toys, food packaging and medical devices, they are also finding increasing use in other near-consumer applications, e.g. floor coverings. Here, all well-known manufacturers of PVC floor coverings are pursuing the development of at least individual product lines using cyclohexanoates (e.g. DINCH), terephthalates or citrates to address consumer demands. It can thus be expected that the number of alternative plasticizers, which was relatively constant over the last 10 years, will increase in the medium term.

The trend toward Ca-Zn formulations to stabilize PVC products has also continued. After cadmium-containing stabilizer systems were eliminated in the EU15 since 2001, in the EU25 since 2006 and in the EU27 since 2007, consumption of lead stabilizers has also declined by more than 76 % in the time period from 2007 to 2012. Here, the European associations of stabilizer producers (ESPA) and PVC processors (EuPC) have agreed to a voluntary commitment to complete elimination (see below) by the end of 2015.

The new sustainability program VinylPlus announced in June 2011, which is based on the success of the preceding program Vinyl 2010, is off to a successful start. The objectives are to increase PVC recycling levels, help eliminate the buildup of persistent pollutants in the environment, reduce emissions further, ensure the use of additives on the basis of accepted sustainability criteria, boost energy efficiency and use of renewable energy sources and raw materials in PVC production and increase awareness of sustainable development in the entire PVC value-added chain. For instance, within the framework of VinylPlus, a total of 362,000 t of PVC were recycled in the year 2012. In addition to PVC consumer waste, this figure includes certain process waste from PVC processing. The growing recycling rate and the resulting more efficient and sustainable use of PVC as a material in the EU have an increasingly damping effect on the demand for virgin PVC.

Despite the economic crisis, conversion of chlorine production in the EU from the amalgam to the more environmentally friendly and energy efficient membrane process **(Fig. 7)** has continued and is being pursued further by the European chlorine industry and PVC manufacturers. By the beginning of 2012, the amalgam process had dropped to 32 %, even though some conversion projects were delayed and could not be completed as planned. This trend – away from the amalgam process – can be observed worldwide as well. In accordance with the voluntary commitment by members of Euro Chlor, the conversion in Europe is expected to be completed by 2020.

Market Forecasts

For the next few years, we expect moderate PVC growth of between 3 and 4 % per year worldwide with pronounced regional differences. In the emerging markets, e.g. China or the Indian subcontinent, growth is expected to be between 5 and 8 % per year, while only slight growth is expected for Western Europe. For the USA and Eastern

Fig. 7. By 2020, amalgam technology in Europe will be replaced with environmentally friendly and energy-efficient membrane technology for chlorine production (figure: Vinnolit)

Europe, a relatively dynamic development with growth rates between 4 and 5 % is projected.

The engine of growth in emerging markets remains the still-low PVC per capita consumption with some catching up to do as well as the reviving construction activity, above all, in terms of infrastructure projects. A resurgence in construction activity can also be observed in North America, while Western Europe – with the exception of Germany – still tends to be weak.

Consequently, the European Economic Area will remain unaffected initially by the overall positive global development. For this reason, if and whether the PVC demand level of 2007 will be reached in the EEA is unsure, since it is difficult to assess the extent to which structural effects will influence the market rebound. The relocation of processing capacities from Western to Eastern Europe observed in the past might mean that growth in Western Europe could drop further and that export of semi-finished and finished goods to Eastern Europe would also decline further. On the other hand, high growth in Eastern Europe could have an opposite effect – also driven by a certain pent-up demand – and in turn result in increased export of PVC raw materials to the CIS countries. In the longer term, local production capacities can be expected not to keep pace with growing demand.

The relative market weakness as well as the high raw material and energy prices have further facilitated the urgently required consolidation activities in the European PVC industry: The former chlorvinyl plant of Vinyls Italia Spa, Venice, Italy, has been shut down. With the acquisition of the PVC business of LVM as well as the closing of a 100 kt PVC plant in Runcorn and a 135 kt chlorine plant in Wilhelmshaven, Germany, Ineos ChlorVinyls has taken the first consolidation steps. Arkema has sold its PVC business to the Klesch Group; the new business with the name Kem One, however, is currently in bankruptcy (August 2013). The planned joint venture between Ineos ChlorVinyls (Kerling) and Solvay/Solvin (with the exception of the RusVinyl capacity still under construction and the subsidiaries outside Europe) will permanently change the PVC supplier picture in Europe.

The shale gas-driven renaissance among North American producers is a real "game changer" for the rules of the game around the world – especially for all ethylene-dependent plastic production facilities. Construction of additional ethane crackers in North America will accelerate the development of North American PVC manufacturers as cost leaders and increase their export opportunities.

However, because of still-limited capacities and the concentration on higher-growth regions (South America, Asia), increased PVC exports from North America to Europe are not to be expected in the near term. Thus, for the time being, "only" the export business of European producers themselves will be affected by increased competition. It remains to be seen what will happen as regards shale gas developments in Europe and on other continents. ■

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