Marianna Greta¹⁾, Krzysztof Lewandowski²⁾

The Textile and Apparel Industry in Italy: Current State and Challenges to Further Growth

¹⁾ Technical University of Łódź Department of European Integration and International Marketing ul. Wólczańska 215, 90-924 Łódź, Poland

²⁾ **University of Łódź Institute of Economics** ul. Rewolucji 1905 r. 41, 90-214 Łódź, Poland E-mail: Krzys@uni.lodz.pl Abstrac

Italian products of the textile and apparel industry are known worldwide. This sector has attracted a great deal of attention because it is rare for a wealthy and developed country to specialise heavily in fashion-oriented as well as semi-customised industrial products and base its production system on small and very small companies. The aim of this paper is to present the current situation and future challenges of the Italian textile and apparel sector. The paper is divided into three parts: The first one describes the international and domestic position of the T&A sector, the second – the key characteristics of the T&A sector in Italy, and the third outlines consumer-supplier relations in this sector.

Key words: *Italian industry, textile industry, apparel industry.*

low labour costs and a high investment level, allowing them to increase production quality and thus compete effectively in the global market. In this difficult situation, Italian enterprises need to develop new strategies and products as well as improve quality and flexibility in order to ensure the continued popularity of their products in the fashion sector, thus maintaining competitiveness. The Italian textile sector primarily consists of micro and small enterprises marked by a large degree of production cycle dispersion, especially those specialising in fibre (yarn) treatment in different production phases. Since the 1970s, the textile industry in Italy has been undergoing employment reorganisation due to competition with countries with lower labour costs and the search for more effective production methods.

The level of textile and apparel production in Italy represents a number of specific elements that are essential for activity in the T&A sector at the four basic levels (fibres, textiles, apparel, sales). These elements reveal large complexity but can be briefly summarised as follows:

Firstly, Italy is only a small manufacturer of fibres and other raw materials for the production of textiles and apparel, which obviously results in the significant role this sector plays in the domestic trade balance. In this respect, production activities in the textile and apparel sector depend on the situation in the global market.

Secondly, the country's industrial profile is marked by the presence of a large number of enterprises concentrated and rooted in local systems of significant economic and social importance (industrial districts). These are local systems specialised either in textile or apparel production, or both. Mechanisms for the exchange, development and reproduction of non-material resources (knowledge, experience, trust) are typical of such systems. Companies operating in this sector are characteriaed by a noticeably different rationale, which is not focused on the maximisation of short-term profits (2).

Thirdly, the distribution of apparel in Italy has a special structure, whose distinctive feature is the domination of independent retail vendors. Although the market share of this group is declining, it still constitutes the majority of retail sales volume. The relations between manufacturers and distributors were perceived in the literature as a significant factor in the international competitiveness of the Italian T&A industry (8).

The change in the competitive situation in the global market in recent years has led to the need to undertake actions typical of countries with relatively high labour costs. Thus, the effects of these changes may vary with regard to the time and manner in which the new competitive situation will influence the activities of T&A enterprises.

International and domestic position of the Italian textile and apparel sector

The Italian textile and apparel industry is the European leader. Italy belongs to the leading global exporters of both textiles and apparel. This sector grew successfully in the 1990s, and its revenues from trade have contributed largely to compensating for the negative balance in other economic sectors (power industry, food industry).

The textile and apparel sector is one of the most important sectors of the processing industry in Italy and also plays an important role in the European Union and even on a global scale. Its condition and functioning are also essential for textile and apparel enterprises in Central and Eastern European countries as they purchase Italian textiles and yarn and are engaged in the sale of high-quality processed products which enjoy widespread popularity. Enterprises from a number of Central and Eastern European countries, for example Romania, are important cooperators for Italian textile enterprises, which benefit from their lower labour costs in the processing of apparel products.

The factors which contribute to the success of Italian textiles are primarily the ability to couple innovativeness, fashion and a creative style with production technologies. In recent years, the Italian textile and apparel sector has faced another serious challenge posed by countries with

Italy is one of the leading manufacturers and exporters of textiles, occupying the second position in the world after China, with a 6.5% market share. It is also the third biggest apparel exporter, after China and Mexico, with a 5.3% market share. It is estimated that in the luxury market, ten Italian companies control as much as 20% of the global market, manufacturing goods valued at EUR 40 billion. In particular they hold a very strong position in the American and Japanese markets (4).

This information shows that Italy has been the leader in Europe in the field of textiles and apparel for many years now, which results from the impact which Italian export has had on global export in this sector since the 1960s (6).

Over fifty thousand enterprises with over five hundred thousand personnel operate in the textile and apparel sector in Italy. In 2008, the industry saw a 3% decline in turnover, but this was still 2% higher than in 2005 (14). The sector constitutes part of a larger system comprising other fashion-related sectors, where Italian enterprises also have a strong position (see *Table 1*).

In the 1990s, the Italian textile and apparel industry and market experienced the effects of the globalisation process. The response to this challenge was the strong internationalisation of Italian T&A enterprises, which is demonstrated by the substantial share of export in the turnover, accounting for 60%. Not only was this share maintained, but it even increased in the first years of the 21st century. Italy's positive trade balance concerns both the textile and apparel industries, which distinguishes Italy from other European Union countries. While the trade balance with regard to textiles was positive for the old EU 15, there was a deficit in the apparel industry.

In 2008, the export value of the textile, apparel and footwear industries amounted to EUR 27.8 billion, which meant a 1.1% decline in relation to the previous year. The major consumer of Italian commodities in these sectors was France, which had overtaken Germany. A substantial increase was observed with regard to export to Russia (+8.8%), which exceeded that to the United States, Great Britain, the Netherlands (+8.0%), Austria (+11%), China (11.9%), Ukraine (+11.7%) and Poland (+6.0%).

Table 1. Italian textile and fashion industry in the years 2005 – 2008 (in current EURO million).

Subject	2005	2006	2007	2008
Sales value	51851	52836	54186	52513
Change in %		1.9	2.6	-3.1
Production value	43676	44171	45227	43133
Change in %		1.1	2.4	-4.6
Number of enterprises	61624	59750	58004	57682
Change in %		-3.0	-2.9	-0.6
Number of employees	524930	516674	512956	503855
Change in %		-1.6	-0.7	-1.8

Source: SMI Federazione Imprese Tessili e Moda Italiane, Il settore tessile – moda italiano nel 2008 – 2009, Firenze, 05.05.2009, p.1.

Table 2. Major consumers of Italian goods in the textile, apparel and footwear sectors in 2008 by country of destination.

Country of destination	Volume of turnover in EUR million	Change % in relation to the previous year	Share %
France	2864	+1.2	10.3
Germany	2739	-6.6	9.9
Spain	1944	-5.6	7.0
Switzerland	1580	+5.8	5.7
Russia	1573	+8.8	5.7
United States	1551	-11.1	5.6
Great Britain	1421	-10.2	5.1
Hong Kong	985	-1.5	3.5
Romania	887	-0.1	3.2
Japan	835	-10.3	3.0
Netherlands	754	8.0	2.7
Greece	743	3.3	2.7
Tunisia	654	-0.3	2.4
Belgium	611	-4.5	2.2
Turkey	576	-8.3	2.1
Austria	556	11.0	2.0
Poland	551	+6.0	2.0
Portugal	484	-2.6	1.7
China	395	11.9	1.4
Ukraine	363	11.7	1.3
TOTAL	27774	-1.1	100.0

Source: SMI Federazione Imprese Tessili e Moda Italiane, Il settore tessile – moda italiano nel 2008-2009, Firenze, 05.05.2009, p.4.

The same year, the import value amounted to EUR 17.8 billion, which meant a 0.8% decrease. The major supplier remained China, which even increased its import share to almost a quarter. Other Asian countries: Bangladesh (+19%) and Sri Lanka (+12.7%) also saw a substantial increase; although in the case of India, a 7.5% decrease was observed. Traditional EU partners e.g. France and Germany saw a decline in their share of the Italian market (see *Table 2* and *3*).

The T&A sector is an essential part of the Italian processing industry. It has a 10% share in Italy's turnover, employment and export and generates one third of the Italian trade balance surplus. These figures

are much larger than in other developed European countries.

Exports of textile products showed great dynamic in the 1990s. In spite of the decrease in the volume of exports at the beginning of the 21st century, Italy retained its position in the global market. As regards the turnover and investment volume, Italian enterprises stand out against other European Union countries. The production activity of Italian enterprises plays the largest role in both the textile and apparel sectors: 27% of the turnover and 24% of the investment of the old EU 15 in the textile sector went to Italy. As regards the apparel sector, the position of Italy is even stronger – its share ac-

Table 3. Major foreign suppliers of textile, apparel and footwear industry goods to the Italian market in 2008 by country of origin.

Country of origin	Volume of turnover in EUR million	Change % in relation to the previous year	Share %
China	4293	+7.6	24.2
Turkey	1177	+3.1	6.6
Germany	1134	-11.1	6.4
France	1085	-6.5	6.1
Romania	1062	+0.5	6.0
Tunisia	935	+2.2	5.3
India	763	-7.5	4.3
Spain	642	+5.6	3.6
Belgium	545	+8.1	3.1
Bulgaria	386	-1.8	2.2
Great Britain	375	1.6	2.1
Bangladesh	369	+19.0	2.1
Netherlands	353	-4.9	2.0
Pakistan	297	-2.9	1.7
Czech Republic	252	-4.5	1.4
Croatia	240	3.4	1.4
Sri Lanka	230	12.7	1.3
Portugal	219	-1.4	1.2
Switzerland	213	-1.4	1.2
Hungary	190	-39.7	1.1

Source: SMI Federazione Imprese Tessili e Moda Italiane, Il settore tessile – moda italiano nel 2008 – 2009, Firenze, 05.05.2009, p.4.

Table 4. Most important Italian industrial districts connected with the textile and apparel sector (data as of 2000).

Industrial district	Turnover (apparel sector) in EUR million	Turnover (textile sector) in EUR million	Export %	Number of enterprises	Number of employed
Vicenza	3415	2448	29 31	1312 769	20300 16100
Prato	1210	3995	59 54	3056 6023	14096 36300
Treviso	4957		27	3821	38457
Bergamo	4191		24	2104	32515
Biella		3600	40	1300	25000
Brescia	2197	1312	20 24	1520 400	15240 5500
Asse del Sempione	_	2700	40	3900	36360
Como		1685	59	2400	27000
Castel Goffreddo	_	1150	51	280	6600
Carpi	_	1100	36	2000	11000
Lecce		750	60	170	3400
Empoli	570	_	30	521	6210
Val Vibrata	310	_	38	400	6000
Valle del Liri-Sora	130	_	20	194	2000
14 districts	16980	18740	37	30170	302078

Source: Sistema Moda Italia (SMI) – ISTAT – Club dei Distretti, Unione Industriali di Bergamo, Biella, Brescia, Como, Prato, Vicenza.

counted for 37% of the turnover and 48% of the investment in the old EU 15.

The investment index per 1 person employed in Italian enterprises provides interesting information. In the textile sector, investment per 1 worker is lower than

the European average but slightly higher than in Germany or France. As regards the apparel sector, the situation is entirely different – investments per 1 worker are considerably higher than the Community average and twice as large as in Great Britain. Although Italy observed a de-

cline in employment in the textile sector, this decrease was still relatively smaller than that in France and Germany. This adverse phenomenon also occurred in the apparel sector. While in the years 1996 – 2002 the largest European countries observed a decline in employment, even by 40%, in Italy employment increased by 1% in the same period.

On the whole, the development of the T&A industry in Italy was different than in other old EU countries.

Characteristics of the textile and apparel sector in Italy

The position of the textile and apparel sector in Italy distinguishes this country from others by its high labour costs. In order to explain this phenomenon, it is also necessary to take into account other features of a qualitative nature which may have an impact on this sector. These features primarily concern production organisation in the T&A sector as well as the structure of distribution channels in the apparel industry.

As regards the structure of the industry, Italian textile and apparel enterprises are relatively numerous, on the other hand they are limited in size and organised in local systems corresponding to industrial districts (1). Regarding distribution, a larger share of the Italian market belongs to traditional and independent retailers, while in Europe large enterprises and specialised distribution networks prevail in the textile and apparel industry.

The relation between these two factors has been studied by a number of economists. Michael Porter saw the Italian distribution system as the main reason as to why manufacturers in this sector have a strong competitive position (8). Other authors emphasise that this "special demand" could have contributed to an improvement in the innovative capability of enterprises in the local systems (2).

Numerous quantitative and qualitative analyses have shown that Italian districts are different from other areas in a number of respects: the enterprises operating in these areas are marked by the local vertical division of labour, whereas in other areas they tend to be clusters which manufacture the same products; in Northeast and Central Italy master brokers (impannatore) play a significant role in the local production systems — they organise

production activities and market local products as a final output with a local independent brand name, while in other areas T&A sector companies are frequently either subcontractors of larger external enterprises or sellers of intermediate products on open markets (10).

The success of the Italian T&A industry resulted from the implementation of a cooperation network strategy and the considerable fragmentation of markets, where the importance of returns to scale for an individual enterprise is limited (6). This led to a reduction in standard production and a focus on small market niches. The achievement of a larger scale of business activities not only at the level of single enterprises but at the local system level was, in the case of these enterprises, the consequence of improving the innovative potential and number of local development policy instruments (training of a specialised labour force, joint marketing, participation in fairs etc.).

A high degree of company integration in local systems has given rise to the creation of external returns to scale in the specific geographical context. This is particularly noticeable in industrial districts, some of which are places of concentration of a considerable number of Italian textile and apparel enterprises (see *Table 4*).

For a long time, cooperation within the delivery chain has been perceived as one of the key factors contributing to the success of the apparel industry, where enterprises organised vertically have been replaced by a system of cooperating companies (5). Such a production structure in the textile and apparel sector results in the market position of large enterprises (operating also in Italy) not being as significant as in other countries. As regards the largest Swedish companies, the volume of their turnover exceeds the domestic production value in this sector by a few times (see Table 5).

As regards apparel distribution, Italy is characterised by the strong position of a strategic group of independent retailers, which represented over half of apparel sales in the Italian market in 2002. This figure was much higher than in other European Union countries, where the share of retailers marginally exceeds 30%. In the 1990s, independent retailers lost part

Table 5. Relation of the turnover of the largest enterprises to the total domestic production in the apparel industry in 2001.

Country		Number of enterprises				
	Three largest	Five largest	Ten largest	Fifteen largest		
Sweden	417.1%	497.9%	613.2%	673.1%		
Netherlands	89.0%	n/a	n/a	n/a		
Germany	40.4%	55.5%	79.6%	93.6%		
Great Britain	25.0%	35.6%	54.2%	61.7%		
Spain	26.9%	36.3%	44.9%	50.5%		
France	22.4%	30.7%	46.7%	56.5%		
Italy	16.6%	23.8%	33.2%	39.3%		
Portugal	7.3%	8.8%	11.2%	12.7%		

Source: Euratex-Bulletin, No 1/2003.

Table 6. Share of major strategic groups in terms of apparel sales in Italy.

Strategic group	1999	2002	2005
Independent retailers	55.7	54.0	52.0
Specialised chain stores	14.0	14.5	16.0
Large wholesale traders	15.0	16.0	18.0
Door-to-door selling	9.8	10.8	10.0
Other	5.5	4.7	4.0
Total	100.0	100.0	100.0

Source: S. Guercini, Specifità del tessile – abbigliamento italiano ed evoluzione dei rapporti acquirente – fornitori, in: A. Burresi (a cura di), Il marketing della moda. Temi emergenti nel tessile – abbigliamento, Firenze University Press, Firenze 2005, p.19.

of their share in the markets of EU member countries to specialised chain stores, department stores, hypermarkets and supermarkets. In Italy the share of independent retailers has declined, but not as steeply as in other countries and still remains at a very high level (see *Table 6*).

Apart from the key features of the Italian textile and apparel sector discussed above, i.e. the significant role of industrial districts and independent retailers, Italian manufacturers are distinguished by other features which, in part, result from these two basic characteristics.

Firstly, Italian enterprises hold a strong position in a number of segments, such as woollen textile products, yarn and fabrics. Secondly, an essential feature of Italian products is low costs in relations between enterprises. This results from the fact that they operate within districts, which influences their strategies of cooperation. This reason for success may, however, delay or impede the change of suppliers or customers, who may not be interested in solutions which are not tested

Ties within the district may delay the process of production decentralisation which commenced in the late 1980s amongst Italian textile and apparel companies (9). The beneficiaries of this process included both countries located close to Italy, such as Romania, and remote countries, such as China. This is confirmed by the statistics for Italian foreign trade in intermediate textile products. The role which both countries play in the process of the acquisition of resources by Italian enterprises is, however, different.

Romania not only holds a strong position among the countries of origin of imported commodities but is also one the major countries of destination for exported commodities. This country is actually a consumer of intermediate products manufactured in Italy, and it is there that labour-consuming production stages are realised.

China's position is totally different – nowadays this Asian country is the leader among the countries of origin of textile and apparel products imported to Italy, but it is absent in the group of countries where Italian products are exported to. The trade balance of textile and apparel products regarding China and Romania is unfavourable for Italy, particularly with respect to China. Intermediate textile products manufactured in China of Italian origin are relatively few.

Literature reveals that the Italian textile and apparel sector has benefited from considerable support at the national and even community level (3). Italy is the only large EC country which has observed, due to political reasons, the considerable bailout of a number of important enterprises in the textile and apparel sector. According to some authors, these activities were aimed at maintaining production in particular geographical areas.

Public support also seems very important at a local level and is manifested in various support policies. This assistance is motivated by the significance attached to this sector by local authorities, especially in industrial districts. The actions undertaken have contributed to greater specialisation in the textile and apparel sector, but on the other hand they have led to a reduction in research and development investments and a slowdown in other sectors which could constitute an alternative to its development.

The commitment to protect the T&A industry demonstrated by Italian entrepreneurs operating in industrial districts is also demonstrated by retailers, which make this industry play such a significant role in the distribution of apparel in Italy. This commitment is manifested by the mobilisation of human, financial and intellectual resources, which constitute a form of resistance against the sector's decline in Italy; at least in the context in which this decline was experienced by other highly developed countries.

Evolution of supplierconsumer relations in Italy

Nowadays, Italian textile manufacturing enterprises contend not only with economic problems resulting from the international consumption crisis but also with structural problems stemming from concurrent changes in customers and the emergence of new competitors. These two factors (new customers and competitors) are strongly related to each other as customers are now able to change their suppliers more easily.

A change in supplier-consumer relations has also occurred in the textile and apparel sector, which has always been marked by a special production cycle and special business relations. In the case of a large number of enterprises, this has resulted from a change in the customer profile and purchasing strategies, with the dis-

tribution phase becoming increasingly significant.

The distribution functions and process management important for chain retailers are at the centre of attention in this sector, showing that the competence of retailers is becoming a significant factor in relations within the sector. Due to this reason, achieving competence in distribution and marketing has become important not only for apparel manufacturers but also for those of intermediate textile products who establish relations with entities controlling retail stores.

As opposed to traditional clothing stores, large specialist and brand-name companies do not limit themselves to retail trade but also present their fashion collections, and in this way they implement the process of the integration of research and development functions in the creation of clothing lines for the apparel industry. The change in distribution relations is of a structural character, with serious implications for textile and apparel enterprises.

As regards manufacturers of intermediate textile products, the change involves the need to enter into more direct relations with retailers and increase the importance of this through the formulation of marketing activities and participation in innovative processes. For entrepreneurs manufacturing intermediate products for the apparel industry, departure from customers who are "apparel manufacturers" to those who are "retailers" involves the adoption of their rationale.

Brand-name apparel vendors enter into cooperation with textile and apparel suppliers who are usually engaged in customised production. They may be based in countries remote from their direct customers and are selected according to criteria which first and foremost take into account manufacturing costs. Such suppliers may change over time (7).

At present, the customers of Italian textile and apparel manufacturing enterprises are highly heterogeneous in respect of their role in the sector, their competence, and rationale of their choices. This factor reflects the complexity of the market and impedes the coherent positioning of processing enterprises.

Large distributors of brand-name apparel provide services in direct relation to the final consumer. In direct relations with such distributors, the innovative process (product-driven and process-driven) of the manufacturer depends significantly on the distributor's expectations. Thus, one can observe a departure from a collective process in the formulation of an offer for customers, in which textile manufacturers, apparel manufacturers and retail vendors participate, towards asymmetric power relations with entities which manage the distribution processes, as well as towards the reorganisation of the process, which becomes aimed at the market rather than at production.

Summary

The Italian textile and apparel sector is characterised by complexity and distinctness, which does not mean that it is not subject to the same pressure and processes which influence this sector in other developed countries with high labour costs; rather it means that the evolution and results of these processes are noticeably different.

In the global market, manufacturing no longer occupies a dominating position in the sector. In this context Italian textile and apparel enterprises which have been active in international markets for a long time in search of sales opportunities and suppliers are no exception. In particular, enterprises operating in the phase of textile and apparel production tend to change their strategies and customers.

The customers of Italian textile and apparel enterprises are primarily manufacturing companies, then come retailers, and finally large distributors from a large number of countries including both traditional markets such as Germany, France and the United States, and emerging markets. Nowadays, enterprises engaged in the distribution of apparel must make difficult strategic choices (trade-offs) between product complexity and the global supply chain as well as between intermediate product costs and the costs of adjusting fashion collections to customer tastes.

The factors which have contributed to the success of the Italian production system even include the ability to implement a cooperation strategy, the high quality of products, and substantial creativity. The production structure is characterised by the large role of local production systems and their specific form of entrepreneur-

ship. The distribution structure and customer profile are distinct features of the Italian apparel sector. The Italian system is not dominated by large chain stores, and industrial manufacturers still play an important role in the sector.

References

- Beccatini G.,(ed.) Mercato e forze locale: Il distretto industriale, Il Mulino, Bologna 1987.
- Becattini G, Dei Ottati G., Problemi e prospettive attuali dei distretti industriali italiani, Atti del Colloqui international sur: L'Italie entre le Xxe et le XXIe siecle: la transition infinie, Université Paris III, Paris 2004.
- 3. De la Torre J., Clothing industry adjustments in developed countries, Macmillan, Basinstoke 1984.
- Guercini S., Specifità del tessile abbia gliamento italiano ed evoluzione dei rapporti acquirente – fornitori, in: A. Burresi (a cura di), Il marketing della moda. Temi emergenti nel tessile – abbigliamento, Firenze University Press, Firenze 2005.
- Johnston R., Lawrence P.R., Beyond vertical integration – the rise of the value-adding partnership, "Harvard Business Review", July – August 1988.
- 6. Jones R.M., The apparel industry, Blackwell Publishing, London 2002.
- 7. Popp A., Ruckman J.E., Rowe H.D., Quality in international clothing supply chains: a preliminary study, Journal of Fashion Marketing and Management, vo. 4, n. 2/2000.
- Porter M.E. (ed.), The competitive advantage of nations, Macmillan, London 1990.
- 9. Scheffer M., Trading places, University of Utrecht, Utrecht 1992.
- Storper M., Regional "worlds" of production: learning and innovation in the technology districts of France, Italy and the USA, in: R. Rutten, F. Boekma, The Learning Region. Foundations, State of Art, Future, Edward Elgar Publishing, Cheltenham Nordhampton 2007.
- 11. Teece D.J. (ed.), The competitive challenge, McGraw-Hill, New York 1986.
- Thorelli H.B., Networks: between markets and hierarchies, "Strategic Management Journal", vol. 7/ 1986.
- 13. Euratex Bulletin, No 1/2003.
- Sistema Moda Italia, Federazione Imprese Tessili e Moda Italiane, Il settore tessile moda italiano nel 2008-2009, Firenze, 05.05.2009.
- Sistema Moda Italia (SMI) ISTAT Club dei Distretti, Unione Industriali di Bergamo, Biella, Brescia, Como, Prato, Vicenza 2000.

Received 17.05.2010 Reviewed 13.07.2010



INSTITUTE OF BIOPOLYMERS AND CHEMICAL FIBRES

LABORATORY OF BIODEGRADATION

The Laboratory of Biodegradation operates within the structure of the Institute of Biopolymers and Chemical Fibres. It is a modern laboratory with a certificate of accreditation according to Standard PN-EN/ISO/IEC-17025: 2005 (a quality system) bestowed by the Polish Accreditation Centre (PCA). The laboratory works at a global level and can cooperate with many institutions that produce, process and investigate polymeric materials. Thanks to its modern equipment, the Laboratory of Biodegradation can maintain cooperation with Polish and foreign research centers as well as manufacturers and be helpful in assessing the biodegradability of polymeric materials and textiles.

The Laboratory of Biodegradation assesses the susceptibility of polymeric and textile materials to biological degradation caused by microorganisms occurring in the natural environment (soil, compost and water medium). The testing of biodegradation is carried out in oxygen using innovative methods like respirometric testing with the continuous reading of the CO₂ delivered.



The laboratory's modern MICRO-OXYMAX RESPIROMETER is used for carrying out tests in accordance with International Standards.

The methodology of biodegradability testing has been prepared on the basis of the following standards:

- testing in aqueous medium: 'Determination of the ultimate aerobic biodegrability of plastic materials and textiles in an aqueous medium. A method of analysing the carbon dioxide evolved' (PN-EN ISO 14 852: 2007, and PN-EN ISO 8192: 2007)
- testing in compost medium: 'Determination of the degree of disintergation of plastic materials and textiles under simulated composting conditions in a laboratory-scale test. A method of determining the weight loss' (PN-EN ISO 20 200: 2007, PN-EN ISO 14 045: 2005, and PN-EN ISO 14 806: 2010)
- testing in soil medium: 'Determination of the degree of disintergation of plastic materials and textiles under simulated soil conditions in a laboratory-scale test. A method of determining the weight loss" (PN-EN ISO 11 266: 1997, PN-EN ISO 11 721-1: 2002, and PN-EN ISO 11 721-2: 2002).





The following methods are applied in the assessment of biodegradation: gel chromatography (GPC), infrared spectroscopy (IR), thermogravimetric analysis (TGA) and scanning electron microscopy (SEM).

Contact:

INSTITUTE OF BIOPOLYMERS AND CHEMICAL FIBRES ul. M. Skłodowskiej-Curie 19/27, 90-570 Łódź, Poland Agnieszka Gutowska Ph. D., tel. (+48 42) 638 03 31, e-mail: lab@ibwch.lodz.pl