Technical Bulletin
Compostability

LENZING™ Viscose, LENZING™ Modal and LENZING™ Lyocell are fully compostable in soil conditions.

Standard nonwoven and standard textile fiber types of LENZING™ Viscose (raw white and color), LENZING™ Modal (raw white and color), and LENZING™ Lyocell are fully compostable and biodegradable in soil, as defined in the EN 13432 European norm. This norm is the strictest of all the ones applied to the evaluation of compostability and biodegradability. The norm also clearly defines the difference between compostability and biodegradability. These terms are frequently used erroneously. The EN13432 European standard establishes that a compostable material must be:

Biodegradable

- **Biodegradability** is determined by measuring the actual metabolic conversion ensuing through microbial activity of the compostable material into CO_2. This property is determined quantitatively. This is done by using the EN14046 (or ISO 14855) standard test method. The acceptance level is 90%. This has to be achieved within 6 months.

- LENZING™ Viscose and LENZING™ Lyocell were tested during 45 day and 55 day periods respectively, at a low temperature of 28° C (ambient temperature), This was done to simulate home composting conditions. It is postulated that a material that is biodegradable at low temperature will certainly be such at any higher temperature. This is because the microbial activity increases with temperature. LENZING™ Viscose and LENZING™ Lyocell biodegraded rapidly - in less than 2 months at low temperatures, as shown in figure 1 and figure 2.

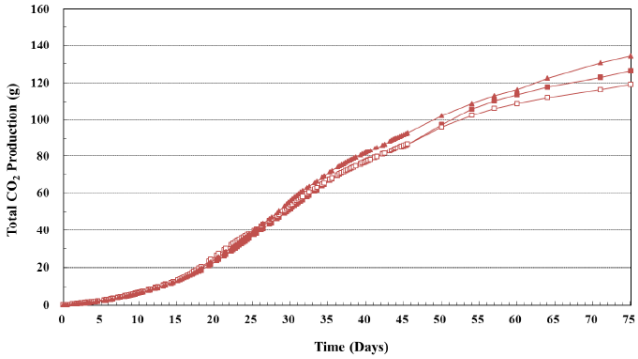

Fig. 1 The biodegradation of LENZING™ Viscose at 28° C started after a lag phase of 9 days and proceeded at good rate. At the end of the test, after 45 days, a plateau in biodegradation - at the level of 93.1%+/- 1.9% - was measured. This translated into a biodegradation of 100.5% on a relative basis, when compared to the suitable reference substrate cellulose.

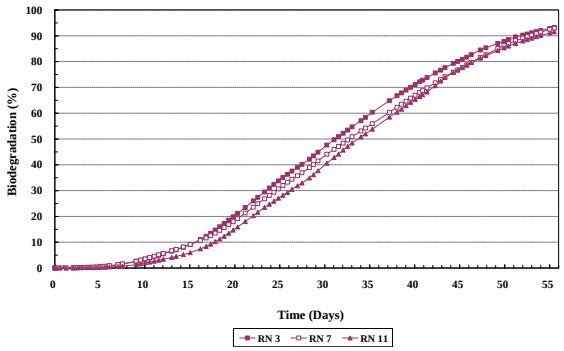

Fig. 2 The biodegradation of LENZING™ Lyocell at 28° C started after a lag phase of 9 days and proceeded at slower rate than that of LENZING™ Viscose. After 55 days a plateau in biodegradation - at a level of 92.6% +0.9% - was observed. This came to 96.7% on a relative basis, when compared to the reference substrate cellulose

Disintegradable

- **Disintegration** is the fragmentation of a compostable material into smaller pieces, thus producing the loss of its identifiability and visibility in the final compost. This is measured using the EN14045 composting test.

- The test material and organic wastes are mixed and jointly degraded for 3 months. The compost is then sieved using a 2 mm sieve. The residues of the test material whose dimensions are greater than 2 mm are considered as not having disintegrated. Their share must be less than 10% of the initial mass. LENZING™ Viscose and LENZING™ Lyocell disintegrated swiftly at ambient temperature - as shown in figure 3 and 4:

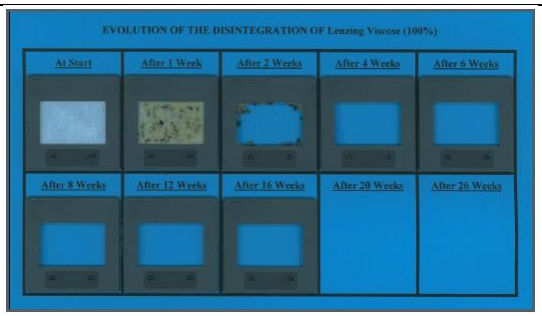

Fig. 3 A very swift disintegration was observed at ambient temperature for the test material LENZING™ Viscose (273 µm – 55 g/m^2). After 6 weeks the test was concluded. This was because the material was completely disintegrated.

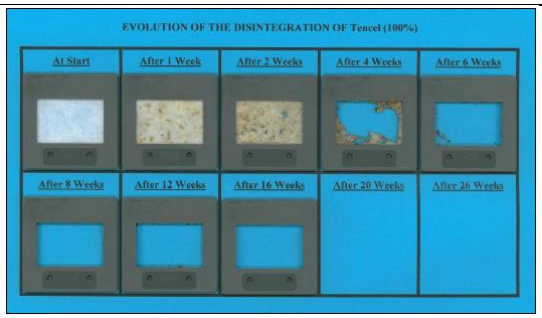

Fig. 4 The disintegration of LENZING™ Lyocell fibers at ambient temperature (384 µm -62 g/m^2) proceeded very well. After 16 weeks they were completely disintegrated.

Compost Quality (material characteristics and compost analyses)

- A **compostable** material has to prove that it does not negatively affect the composting process and the compost quality. To achieve this, the norm establishes treshhold levels on volatile matter, heavy metals (Cu, Zn, Ni, Cd, Pb, Hg, Cr, Mo, Se, As) and fluorine, as shown in table 1. This table also details the treshhold levels set by the USA's ASTM D6400 standard, which thus serves as a comparison. All LENZING™ fibers tested had results far below the limits.

Metal	Limit values		
	Europe EN 13432 (2000)	USA* ASTM D 6400-12	Canada BNQ P 9011-911-5
Zn	< 150	< 1400	< 463
Cu	< 50	< 750	< 189
Ni	< 25	< 210	< 45
Cd	< 0.5	< 19.5	< 5
Pb	< 50	< 150	< 125
Hg	< 0.5	< 8.5	< 1
Cr	< 50	-	< 265
Mo	< 1	-	< 5
Se	< 0.75	< 50	< 4
As	< 5	< 20.5	< 19
F	< 100	-	-
Co	-	-	< 38

Table 1 Acceptance limits of heavy metals and fluorine according to international standards [ppm]

A plant growth test is carried out using compost samples once the degradation of the test material has taken place. No differences are to exist between this material and the control compost.

- Tests of barley and cress growth were carried out using LENZING™ Viscose and LENZING™ Lyocell compost. Compost was obtained from the pilot-scale composting of the fibers. The compost had none of the residuals – such as metabolites, undegraded components or inorganic materials – that could have negatively affected the germination and growth of barley and cress plants.

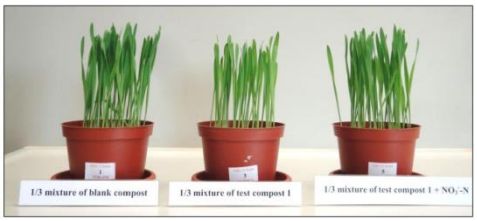

Fig. 5 Demonstration of barley growth after an incubation period of 7 days (from left to right): soil featuring 1/3 mixture of blank compost, of 1/3 mixture of test compost 1 and of 1/3 of test compost 1 with nitrate addition

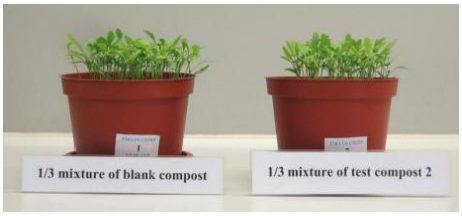

Fig. 6 Demonstration of cress growth after an incubation period of 13 days (from left to right): soil featuring 1/3 mixture of blank compost, and soil featuring 1/3 mixture of test compost 1.

Standard nonwoven and standard textile fiber types of LENZING™ Viscose (raw white and Color), LENZING™ Modal (raw white and Color), and LENZING™ Lyocell fulfill the requirements of compostability established by EN 13432 and were thus certified with the TÜV Austria certificates of “OK COMPOST”, “OK COMPOST HOME” and “OK BIODEGRADABLE SOIL”.