

6.2 Appearance testing: pilling testing and evaluation

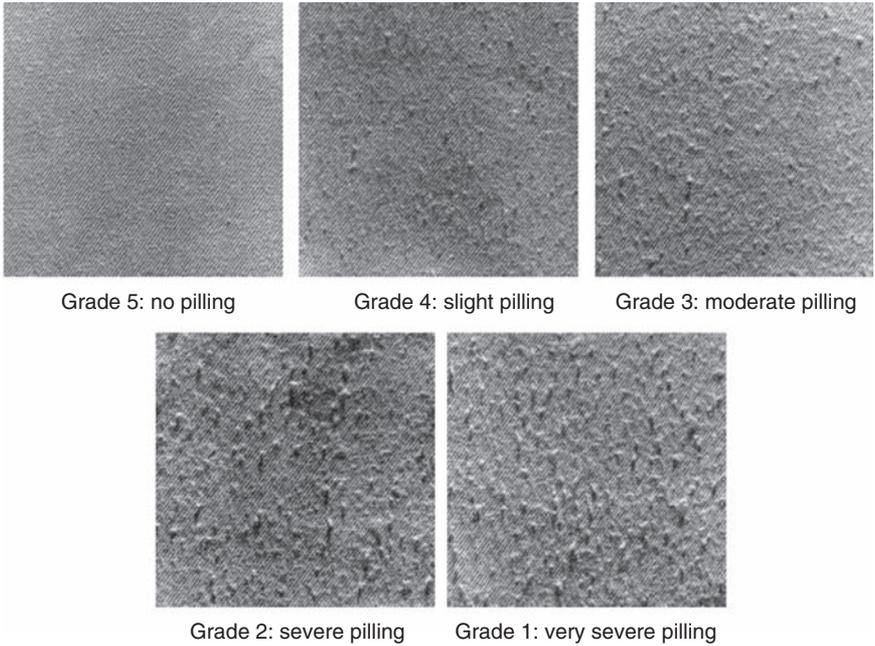
Pilling is a phenomenon of fiber movement or slipping out of yarns, which is usually happening on the fabric surface during abrasion and wear. The development of pilling could be divided into four stages: fuzz formation, entanglement, growth, and wear-off. The formation of fuzz and pills suspended on the fabric surface could affect the fabric aesthetics and its ultimate acceptance by customers. Many researchers are investigating how to improve the pilling resistance ability of cloth, including the optimization of fiber manufacture, yarn manufacture and fabric manufacture. In this case, the standards and testing methods for evaluating the pilling grade of cloth are very important in guiding the technology of pilling resistance optimization. The photographs in Fig. 6.1 show standard pilling images of woven fabrics from grade 1 to grade 5 (see Table 6.1).

Facing-up [1] can be defined as the generation of unwanted surface fibers leading to a change in the appearance of the garment, as illustrated in Fig. 6.2. Facing-up is one kind of surface change which is less serious than pilling. Facing-up is normally associated with knitted yarns made from worsted and possessing a clean surface. Fabrics and knit made from wool spun yarns generally are finished to create a fuzzy or hairy surface and during wear/abrasion the reverse effect is sometimes an issue. Facing-up can occur all over a garment or in localized areas. It is caused by the gradual withdrawal of fibers from the surface layer of yarns (migration) and can in many cases lead to pilling. The migration of surface fibers from the body of the fabric to the surface is due to frictional forces applied to the fibers on contact with other surfaces, which might also include the same fabric. Consequently, facing-up tends to occur when surface abrasion forces are high such as during tumble drying.

6.2.1 Fabric pilling: standards

Fabric pilling or related surface change is commonly tested in the laboratory using specific machines by generating pilling on the fabric by simulating wear. A sample of the original fabric is fixed in the machine and wear is simulated by the action of abrasive materials. Generally, the machines are supplied with a standard reference consisting of photographs of samples

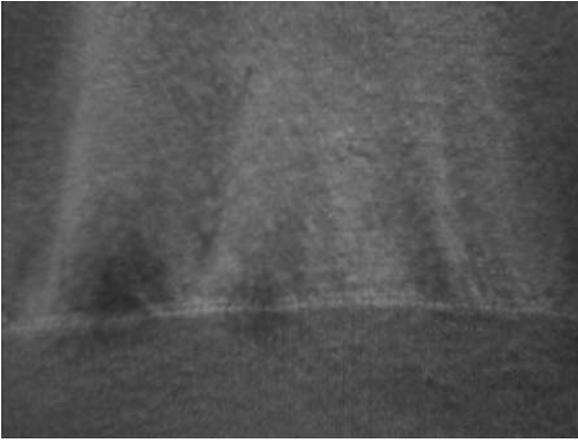
with different degrees of pilling. The abraded fabric is then compared with standard photographs that have been developed by the standards institutions such as ASTM, AATCC, IWS, BIS, JIS, etc., and a degree of pilling is assigned accordingly.



6.1 Pilling standards of woven fabrics.

Table 6.1 Visual assessment of pilling

Grade	Description
5	No change
4	Slight surface fuzzing and/or partially formed pills
3	Moderate surface fuzzing and/or moderate pilling. Pills of varying size and density partially covering the specimen surface
2	Distinct surface fuzzing and/or distinct pilling. Pills of varying size and density covering a large proportion of the specimen surface
1	Dense surface fuzzing and/or severe pilling. Pills of varying size and density covering the whole of the specimen surface



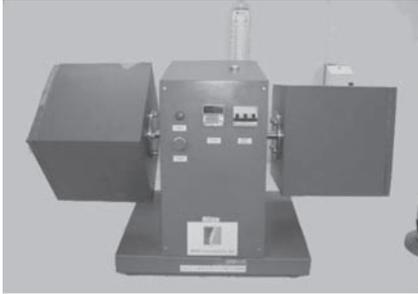
6.2 Facing-up of wool knits.

6.2.2 Fabric pilling: instruments

The most popular abrasion machines (Fig. 6.3) to simulate wear conditions in the market are the ICI pilling box tester, the Martindale tester, and the random tumble pilling tester. The methods of abrasion differ in the following ways.

- *ICI pilling box tester.* Specimens are mounted on the polyurethane tubes and tumbled randomly in a cork-lined box for a certain time.
- *Martindale tester.* Flat abrasion as specified in the ASTM D4970 pilling test. The instrument subjects specimens to a rubbing motion in a straight line that widens into an ellipse and gradually changes into a straight line in the opposite direction. This pattern of rubbing is repeated until fabric threads are broken or until a shade change occurs in the fabric being tested.
- *Random tumble pilling tester.* The specimen is placed in a cylindrical chamber and tumbled around within the chamber which is lined with mildly abrasive materials to brush the specimens to free fiber ends.

The method of abrasion has a significant effect on the pilling appearance. In comparing abrasion instruments, it was noted that the test results could be affected by instrument type, as well as instrument settings. Therefore, the



ICI pilling box



Martindale tester



Random tumble pilling tester

6.3 Pilling testers.

choice of pilling tester should depend on the consideration of material properties and the end-use of products.