bowling balls

Knocking down pins and getting **STRIKES** with polymer science and surface chemistry

A CHEMIST RECENTLY asked me to join his bowling team. During the intense negotiation of my team contract, I inquired about custom-made balls for our squadron. Maybe a transparent ball with an intimidating skull in the center? Or perhaps a test tube or beaker?

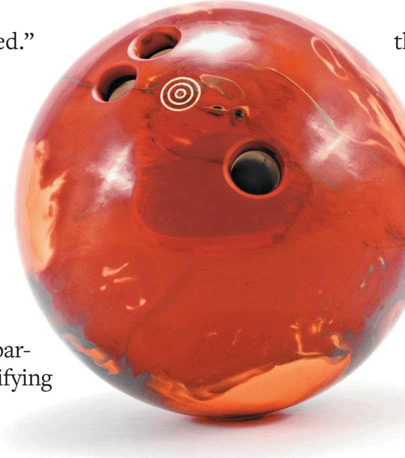
The joke was on me. My friend matter-of-factly replied: "Of course not. That kind of bowling ball isn't used by the pros—it has terrible dynamics." Properly rebuked for my naïveté, I began reading up on bowling science.

The game was invented by the ancient Egyptians, who made their bowling balls by carving stone. Eons later, during the early 1900s, balls were made of wood and then rubber. Around 1960, bowling ball manufacturers used polyester resin for the first time, enabling the production of plastic balls with bright, swirled colors.

Once polymers were introduced, the science of bowling took off. In fact, the materials chemistry of bowling balls has advanced so much that a national governing body, the U.S. Bowling Congress (USBC), now sets regulations on ball manufacturing. "We're always looking at ways to better control the environment of bowling," says Paul Ridenour, a research engineer for the USBC Specifications & Certifications team.

Ten-pin bowling balls are no longer made just of hard solid rubber or plastic. "Modern-day bowling balls are made from a three-piece construction," Ridenour says. The pieces include an inner core, an outer "filler" core, and a shell (or coverstock, in bowling lingo) that work in concert to achieve the ultimate in success on the bowling lanes—the strike.

"The specific, desired weight of a ball is achieved by changing the density of the inner parts," says Victor Marion, a technical service representative at Brigham City, Utah-based manufacturer Storm Products. Heavy 16-lb bowling balls are quite dense, but balls weighing 10 lb or less have such a low density that they can float in water. The exact materials that go into making each part of the ball, Marion says, are considered "proprietary technologies that are closely guarded."


SHUTTERSTOCK

But "it's all straight polymer chemistry," Ridenour notes. The inner core, the shape of which influences rotational properties of the ball, often is made of urethane, and the outer core can be some combination of calcium carbonate, barium sulfate, and emulsifying agents, he adds. Shell materials vary depending on whether a bowler is using the ball to go for a strike or "pick up" a spare.

With a little help from a 7-foot-tall robot named Harry, USBC investigators determined at their climate-controlled bowling research facility in Wisconsin that a ball's surface roughness is the parameter that most affects its overall performance.

MOST PROFESSIONAL bowlers, for whom anything less than a strike amounts to failure, use balls with reactive resin shells that can create a lot of traction-generating friction with the lane, Ridenour notes. Like tire treads in snow, the surface pores in a reactive resin ball can absorb the mineral oil used to lubricate the bowling lane and allow the ball to gain traction as it rolls. Rather than skidding straight down the lane as hard-surfaced, lower friction polyester coverstock balls do, reactive resin balls can "hook" or curve across the lane, given a little applied "spin" from the bowler. Pro bowlers use this hooking technique to gracefully arc the ball into the pins, aiming slightly behind the head pin for a sweet spot called the pocket.

First marketed in the early 1990s, reactive resin shells—used to help improve ball friction—are a mixture of urethane and a proprietary ingredient that generates surface porosity while the polymer base cures. Ball makers mix isocyanates and polyols to form the base urethane resin, but companies are loath to reveal the exact identity of the various reactive plasticizer ingredients they use, Ridenour says.

Some manufacturers have gone even further than reactive resins. In the late 1990s, a particle-based bowling ball coverstock was developed with a single purpose: more aggressive friction with the lane. These shells still have a urethane base but are also mixed with particulates, which can be sharp or hollow and made of "anything from calcium carbonate to potter's glass," Ridenour says.

The USBC tests led to a new specification on bowling ball surface roughness that will take effect next year. Peak-to-valley average roughness can no longer be more than 50 microinches, as measured by a profilometer, the use of which "is akin to dragging a record needle across the surface of the bowling ball," Ridenour says. USBC is also planning future studies on how a bowling ball's performance relates to its materials and surface details: They will use a differential scanning calorimeter to measure the glass transition temperatures of shell materials.

Regretably, the science of bowling indicates that the plastic Elvis-themed bowling ball I've had my eye on may not be the best choice for my new bowling career. But there are other ways of personalizing your bowling ball, my chemist friend told me. "I bought a ball that smells like blueberries," he said.

For those who want a bit of aromatherapy while they bowl, reactive resin and particle bowling balls are available in a variety of fragrances. Incorporated into the coverstock, "the fragrances are engineered to last for at least 10 years," Storm's Marion says. "With the addition of a scented ball to the bag" where "many bowlers store their shoes," he adds, the benefit of a fragrant ball is undeniable. Move over Elvis, here comes chocolate-covered cherry.—LAUREN WOLF

MORE ONLINE To learn more about how USBC conducts its tests and to watch their robot Harry in action, visit www.cen-online.org.