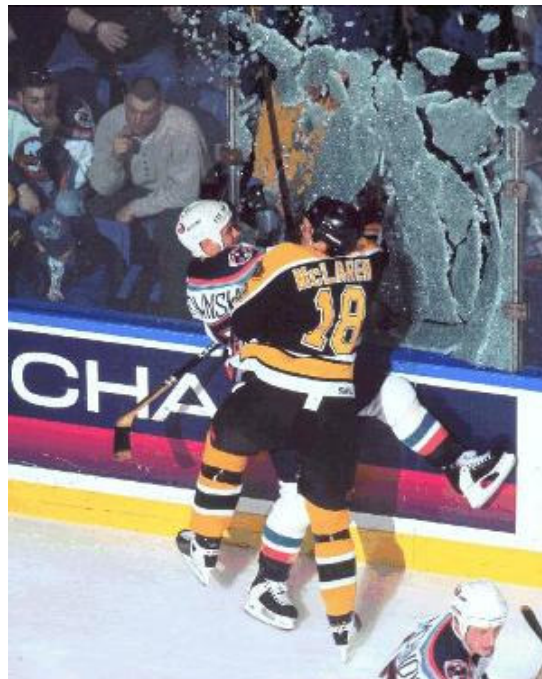


Watching hockey through glass

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If you're like me and prefer to sit high up in the stands, the windows surrounding the hockey rink are not a factor. But for the many fans who like to watch the game at ice-level, the glass that separates them from the play is important. This article explores some interesting properties of these windows and how they affect the viewing experience.

Ice rinks have tall windows for safety reasons: spectators need something transparent that will protect them from pucks, players and sticks. But you can't put just any kind of windows and pretend they are safe. Manufacturers usually employ tempered glass (like at my University's arena) or, as often seen in the NHL circuit, Plexiglas, also known as PMMA. A plastic-like material, Plexiglas is more flexible than glass and will give more during a body check, so players like it better.



To make tempered glass, you simply heat regular glass near its melting point and then cool it quickly with jets of cold air. This not only makes the glass much harder, it also causes it to shatter or “explode” when broken. Glass can't be shaped or drilled once tempered, so it needs to be cut to measure before treatment. If a tiny fracture sets in, it propagates via multiple zigzags and quickly

spreads to the entire window (like in the photo above). For the hockey fan sitting on the other side of a shattered window, it means having millions of broken glass bits on his beer and fries. It's not pleasant, but between that and having a heavy chunk of glass slice through an artery, most people would choose the former. And yes, glass is awfully heavy: an 8x5 ft by 1/2 inch-thick window weighs 270 lbs, so imagine if that broke in half and fell on you. A smart idea is to put a plastic laminate on the window to prevent it to fall apart when it shatters. Car windshields (also made of tempered glass) have such laminate inside.

Plexiglas is not as brittle as tempered glass and more resistant to breaking. It's also less than half the weight of glass, but a large panel is still dangerously heavy. On the downside, Plexiglas is softer and will scratch easily.

Another useful but overlooked purpose of ice rink windows is to protect hockey players against themselves. I've seen players shatter glass during a body check, and from the look on their face I could tell that the awkward bending over the board did not feel good. It's easy to imagine that many lower-body injuries would result from players slamming against boards that only go up to hip-level.

Glass and Plexiglas windows look the same, yet there's an easy way to tell the difference. Because Plexiglas is 5 times less thermally conductive than glass, it feels warmer to the touch. As far as viewing the game goes, both Plexiglas and glass windows offer the same performance, as their index of refraction are both very close (near $n = 1.5$). The refractive index is what determines the amount of light bending when it goes through window and how much light is reflected off the surface. When you look at a play straight in front of you, a total of 8% of the light is reflected off the window's two faces, and the remaining 92% reach your eye. But these numbers depend very much on the viewing angle, as Figure 1 shows. To reduce reflections, one can use anti-reflection coatings, like the ones used on prescription glasses. The problem is, these coatings only work for a limited range of viewing angles.

To give you an idea for what reflections mean if you're watching a game at ice-level, let's say you're sitting right by end-zone face-off circle (where the happy face is in Figure 2). When you're looking at a face-off in front of you, you're receiving 92% of the light. Looking at the net in your own zone (black dotted line), you still get close to 92% of the light, but you'll see 85% of it for face-off at mid-ice (red line). Looking at the other net (blue line), that number drops to 60%. For a face-off in the other zone (green line), you only get 38% of the light, which means the window acts like a mirror and you're more likely to see the cute fan sitting further down the row than the hockey players facing off. That brings me to think: in a game where the play happens to be mostly in the other zone, shouldn't you have to pay only 38% of the ticket price?

But what's bad for the fan is actually good for the hockey player: he can use reflection against windows to quickly spot his teammates.

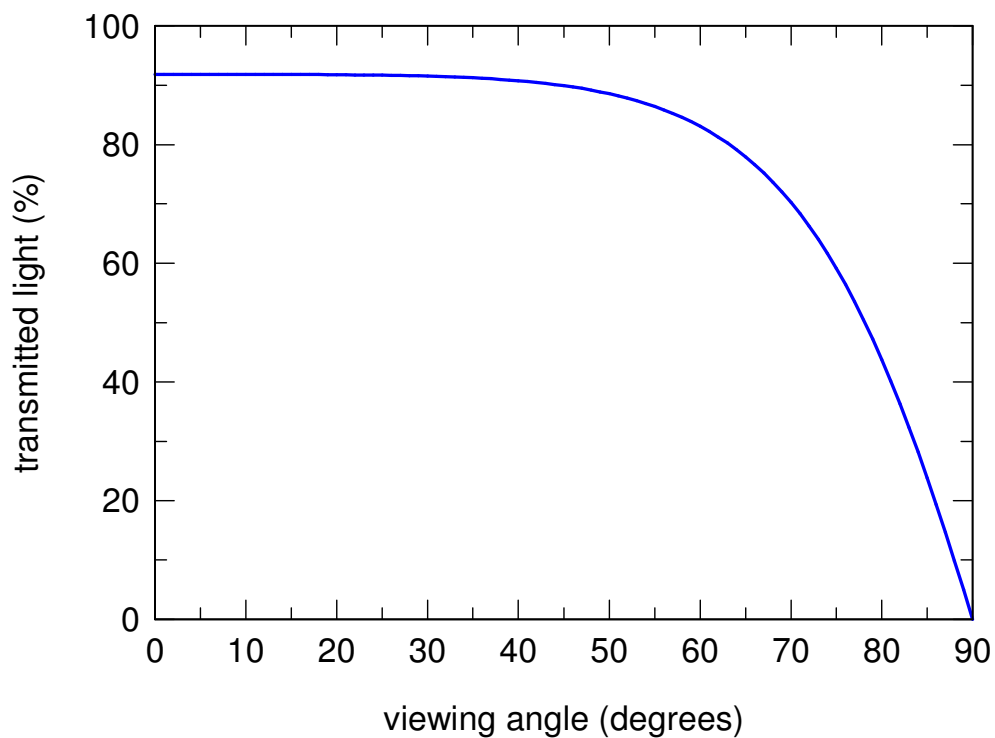


Figure 1: The fraction of light transmitted through glass or Plexiglas. At a 0° viewing angle, light arrives perpendicular to the window (and parallel to it for 90°).

Figure 2: Some viewing angles on an official NHL hockey rink.

