Does Friction Burn the Base?

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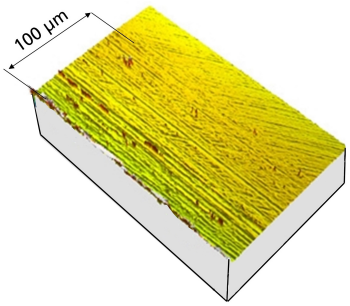
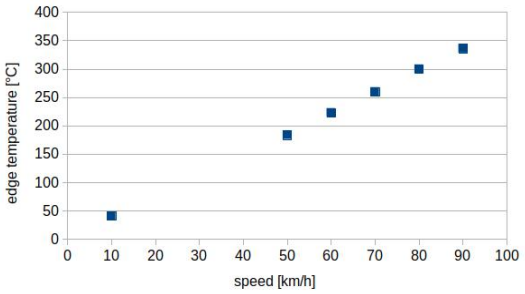
With alpine skis that are used in the World Cup, it is frequently observed that the base under the binding breaks out near the steel edge and has to be replaced. The question is whether these defects are caused by friction or poor quality skis. The following picture shows the area of the steel edge from below that comes into contact with snow or ice. Clearly visible are the grinding grooves caused by the hanging of the edge.



To calculate the temperature that occurs when the ski glides at high speed over the ice, we use the model of Carslaw and Jaeger (Carslaw, H.S. and Jaeger, J.C., 1995. Conduction of heat in solids. Clarendon Press). The boundary conditions are assumed to be those of the giant slalom. We assume that in the curves the athlete mass (100 kg) rests on the lower ski and that the edge is loaded on a length of 30 cm and a width of 0.1 mm. A velocity-dependent coefficient of friction (0.16 to 0.07) of an insufficiently worked edge is assumed. These values are about 10 times larger than those of perfectly polished runners, see (Scherge, M. *et al.*; High-speed ice friction experiments under lab-conditions - on the influence of speed and normal force; ISRN Tribology (2013) 703202 1-6). The program code was written in Python3 and takes into account the necessary material parameters of steel and ice. In addition, a curve radius of 35 m and accelerations due to gravity between 1g to 2.1g, depending on the speed, are used (suva App Slope Track). The diagram shows the calculated temperatures in a speed range up to 90 km/h.



At the highest speed, the friction results in a temperature of nearly 350°C, which is more than 200 degrees above the melting temperature of the ski base (UHMWPE) adjacent to the edge. Although these high temperatures have a residence time only in the millisecond range, they cause the base to be subjected to recurring stresses that fatigue the material. The time course of the degradation also depends, of course, on the quality of the base. Here, the polymer additives in particular determine how serious the defects are. A base with a higher thermal conductivity, e.g. due to carbon black, behaves more stably than an unfilled one.