Impact Fracture of a Metallic Hood Ornament

My car's metal hood ornament broke off! Let's figure out what happened.

Figure 1. Images of hood ornament after fracture.

Figure 1 shows images after fracture of the metallic hood ornament. To analyze the cause of this fracture, we observed the fracture surface via scanning electron microscopy (SEM). SEM is a powerful tool that can analyze the fracture surface of various materials, including metals, ceramics, and polymers. The examination of surface features via SEM is easy to perform and can clearly identify features as small as 5 nm. This level of spatial resolution, along with an incredible depth of field, makes SEM the preferred method of revealing microstructural detail versus optical microscopy. Combined with x-ray energy dispersive spectroscopy (EDS) or backscattered electron imaging, SEM can even identify element and phase distribution over a sample's fracture surface.

Figure 2 shows SEM images of the front and back fracture surfaces of the hood ornament. The front fracture surface shows a relatively flat morphology, while the back is considerably rougher. At 500X magnification, cleavage lines were observed across the Ni coating, which show the direction of crack propagation. Multiple sources of the cleavage lines mean that the rupture was initiated at several positions. The substrate in the front fracture surface also had cleavage facets or breaks between crystallographic planes. Generally, multiple rupture initiations and cleavage fractures are the hallmarks of brittle fracture. In the center of the fracture area, the fracture surface began to tilt or slope at an angle. Even in the Ni coating, the fracture surface had a small shear lip where the fracture surface was oriented at approximately a 45° angle to the applied stress.

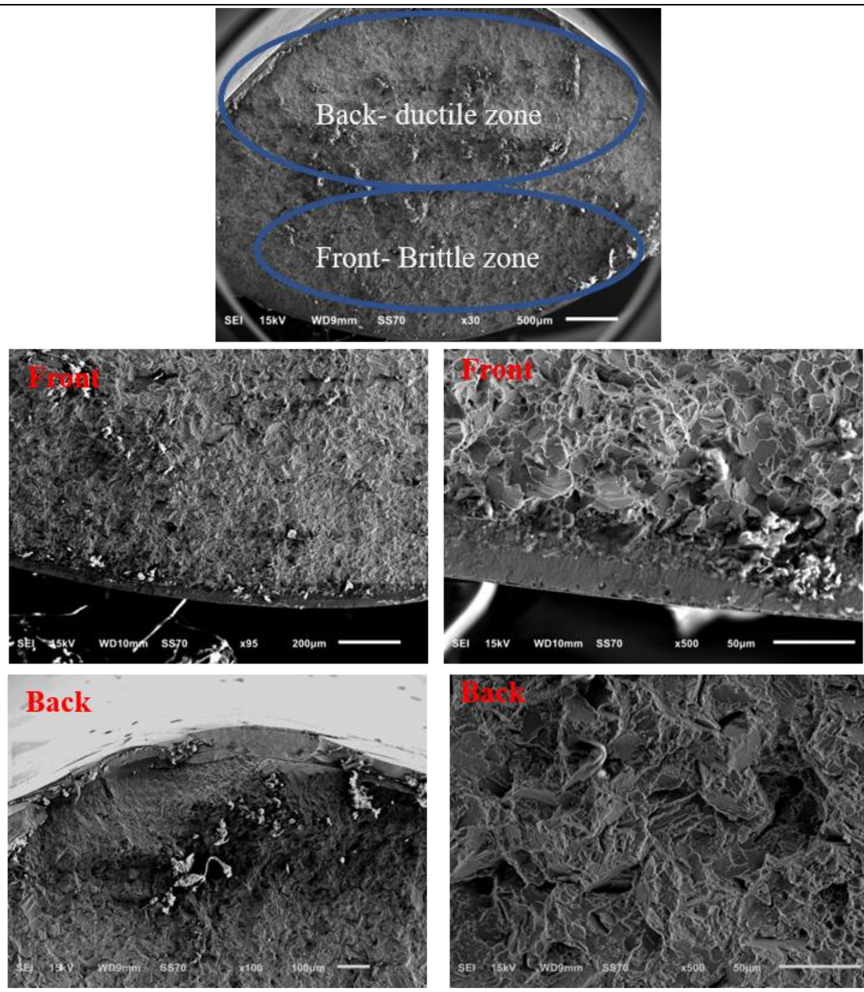

Figure 2. SEM images of the front and back fracture surfaces.

Based upon the differences between the front and back fracture surfaces, the failure was induced by applying a bending force to the emblem. The bending force caused tensile stress to form in the front side of the emblem and compressive stress on the back side. The fracture was initiated near the thinnest part of the front side. Due to this force and the resulting tensile stress on the front side, the fracture surface showed a flat and brittle fracture morphology. The back side of the emblem was in compression and showed a ductile fracture morphology.