Joe Simmons | Hartzell Propeller Inc.

BEWARE THE DODECAHEDRON

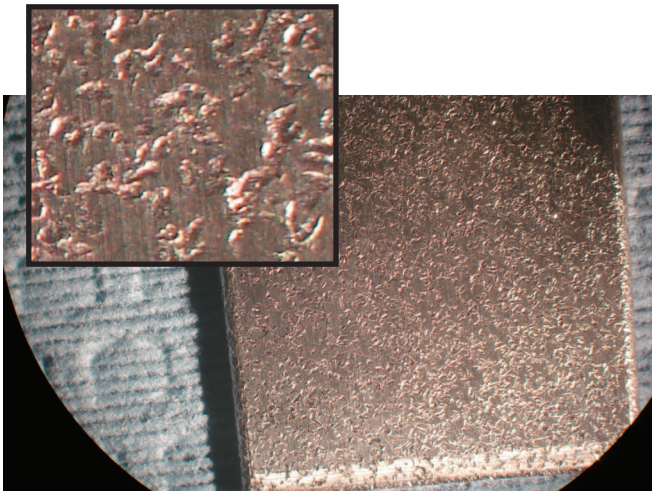
HARTZELL PROPELLER recently had an unusual experience that highlights the importance of defining appropriate media shapes. We think our findings will be helpful to everyone that buys, inspects and uses media and are worth consideration by members of the shot peening sub-committee of Aerospace Metals Engineering Committee (AMEC). This AMEC group is responsible for creating and updating the shot peening specifications used in aerospace.

A Process is Developed

It started when one of our propeller repair stations ordered a batch of conditioned cut wire shot. The media was shipped with certification for AWS-62 per AMS 2431/4. The media passed the repair station's receiving inspection and went on to their new shot peening machine. The media went into the machine, setup work began, and a process was developed. After the sample process was completed, the repair facility sent us a package for audit with a copy of the media certification, a set of Almen strips and an overhauled aluminum scrap part.

Our Internal Audit

The part coverage and masking on the aluminum part passed inspection. The certification document matched our requirements. Everything was on track until we got to the Almen strips and they looked...weird. Their surface was covered in sharped-edged strikes, almost like they had been dented by stabs from a flat-blade screwdriver. We requested a sample of the new shot.



The Almen strip with sharp-edged strikes

A Media Like We've Never Seen Before

We reviewed the shot per AMS 2430. A 10X microscope with single point lighting revealed a new shape of media we have not seen before. We would describe it as "faceted-gemstone-like." It certainly wasn't the typical spheroid with a slight hint of a barrel shape that we are used to with conditioned cut wire. Also, there were a number of smaller size shot particles and a few flat disc-shaped particles mixed in with the faceted shot. It was difficult to see on the aluminum part; however, that its dents were made by faceted shot.

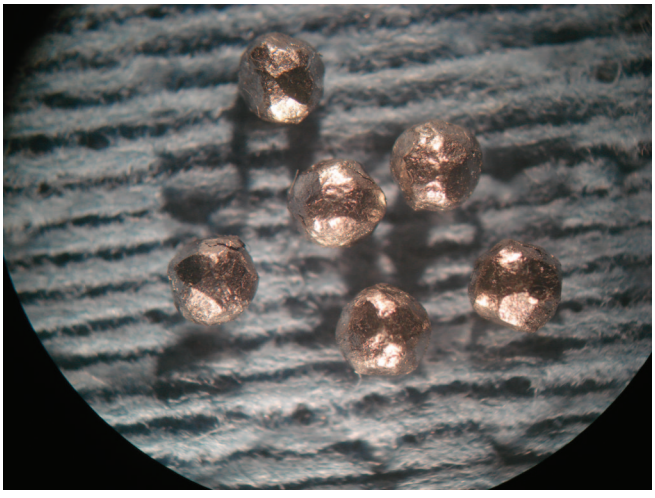
Our Theory

We think that the media supplier created an aggressive conditioning process that imposed a small number of very hard impacts to each particle, possibly as a quick way of conditioning it into something with a spheroid outline but only if you are willing to ignore the sharp edges where the facets meet. We also have to believe that the media manufacturer unknowingly packaged undersized and disc-shaped particles with their "conditioned cut-wire shot." Most of the undersized shot would eventually be wasted in the screening loop. We're not sure what would happen to the disc-shaped media long term but we don't want to use it to make dents in the short term.

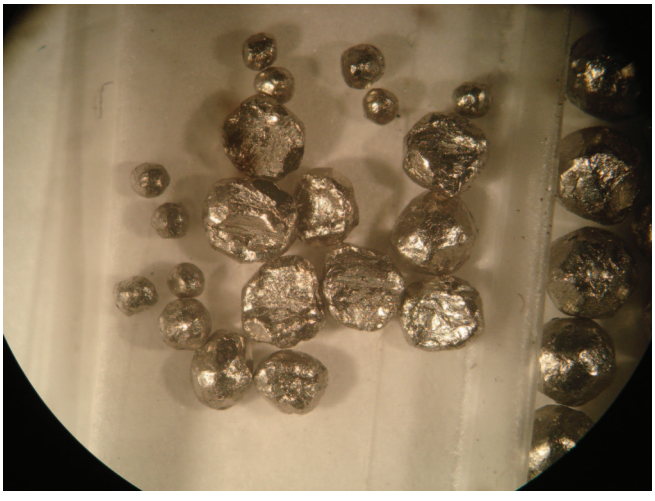
Why the Media Flunked the Audit

We had several reasons for not approving the new process because of the media:

1) A faceted gemstone-shaped sharp-edged particle can't make the desired near-spherical dent.
2) It's not desirable to make dents with flat disc-shaped media while waiting for the screening loop to remove them.
3) The media should have been rejected per AMS 2431/4 Table 2 because it contained more than two (we found eight) unacceptable particles and that's only considering the flat disc-shaped particles. The small sample size of an ounce allowed only four viewed fields instead of the required nine. (We found 20 unacceptable particles if we include the tiny particles that look like AWS 20 that was mixed in by the media manufacturer.) We were inclined to label the discs and AWS 20 as contamination. Note: The media passed the weight and length requirements if we excluded the discs and AWS 20.
4) The media should—would all shot peeners agree?—have been rejected per AMS 2431/4 Table 2 that calls for "shape shall be predominantly spherical." The media exceeds the 63 particle maximum because we judged the full-sized particles as marginal.



The faceted gemstone-shaped media



The undersize and disc-shaped media

Our Conclusions

The media was unacceptable on many levels. First, it's a waste of time and not practical to expect the end user to run his shot peening machine against hardened steel plate to finish conditioning the media, thereby removing the sharp edges and creating spheroid dent makers. Fortunately, other media manufacturers create cut wire shot that is capable of creating a decently shaped dent right out of the bag.

So what can we do to keep poor media from passing inspection, much less entering our shot peening processes? We can improve the intent of AMS 2431/4, AMS 2430 AMS 2431/3 and AMS 2431/8 by adding a new illustration of a partially conditioned particle. For such an illustration, I propose adding a wire frame drawing of a regular dodecahedron and a footnote that references its "facets meeting at sharp edges." Media purchasers, receiving inspectors and shot peening rookies would then be forearmed against the dodecahedron that will harm your shot peening process. The repair station that purchased the unacceptable media certainly could have benefited from additional information. They are new to shot peening and relied on the media's certification. As far as we can tell, they weren't aware of a problem.

As a member of AMEC, I will ask the committee to review my request to add this information to aerospace documents.

About Joe Simmons

Joe Simmons is an Engineering Technician/Shot Peen Developer with Hartzell Propeller, a major supplier of aerospace components. Simmons is an active member and frequent contributor to the Aerospace Engineering Materials Committee Surface Enhancement Committee (AMECSE). AMECSE is the custodian of aerospace specifications on shot peening such as AMS 2430 and AMS 2432.

What is a dodecahedron?

A dodecahedron has 12 faces and each face has 5 edges. It has 30 edges and 20 vertices (corner points) and at each vertex 3 edges meet. The dodecahedron illustrated at the beginning of the article is a "regular dodecahedron" because all of its faces are the same size and shape.