

Evaluating the changing sensitivity of AM powders to segregation and humidity as they are used and recycled

Abstract

Powders can change their flow properties as they are handled and used. They also can become more sensitive to segregation on handling and environmental conditions. This means that a powder that has been used or recycled may change its behavior due to handling and environmental exposure more than virgin material. This behavior is evaluated by testing the flow properties of virgin and used AM powders with the Revolution Powder Analyzer before and after exposure to segregation pressure and different environmental conditions.

Introduction

AM metal powder processes such as laser and electron beam-based powder bed fusion (PBF) and binder jet printing typically require powders that flow well to function properly. Problems such as inconsistent spreadability, poor feeding, and missed layers occur when the feedstock powder either does not flow well enough or blocks feeders and spreaders. These problems can produce inconsistent parts or if severe enough can shut down the production process.

Typically, parts producers test virgin powders as received for various properties including particle size distribution, hall funnel flow and bulk density. Advanced users will also make rheological powder flow measurements by various means. A small sample taken from a larger batch is used for this testing. If the test sample has the “correct” properties then the material is used in production. The correct properties are typically determined by past experience with the powder material. After the powder is used, it is typically recycled by screening and possibly refreshed with additional virgin material. A small sample of the recycled and refreshed powder may then be tested again or may be simply loaded into the printer.

This approach generally works but sometimes a powder that has been producing parts and has tested correctly suddenly stops working well in the printer. Layers are missed or are inconsistent. Spreaders become jammed or blocked or are not fed with powder. Parts are not up to specification. Printer users search for reasons for the failures but many times they remain unexplained. The problem powder will be retested and sometimes powder property changes will be detected but an underlying reason for the change will not be determined. Other times the powder will test correctly. The typical explanations for the failure phenomena are the powder gained a static charge or humidity affected the powder or the powder segregated.

To help determine why seemingly acceptable powders start causing production problems, the flow properties of two sets of virgin and recycled samples powders were tested for sensitivity to humidity and segregation. The flow properties were then compared to determine if the flow properties of recycled samples were more or less sensitive to humidity and segregation than the virgin materials. The powders were exposed to humidity in a oven for two hours and then tested. They were then baked in a 200C dry oven for two hours to dry them. The powders were subjected to segregation stress by flowing them through three successive core flow funnels. The first portion of sample exiting the final funnel was tested. Powders were also subjected to segregation stress by shaking them in a flat pan.

The flow and charging properties of the powders were characterized with the Revolution Powder Analyzer which has been demonstrated to be very sensitive to small changes in AM powders. The analyzer has demonstrated the capability to capture differences in 316L stainless steel powders atomized by argon or nitrogen [1]. The argon atomized powder consistently displayed better flowability than the