Additive Manufacturing as the revolution of wear resistant metals

Dr Ulrik Beste

Co-founder and Chief Technical Officer VBN Components AB

ulrik.beste@vbncomponents.com, +46 70 235 86 26

Most metal Additively Manufactured materials are relatively soft, such as Ti and Al alloys for aerospace, Ni and Co base alloys for high-temperature applications, and stainless steels such as 316L. Low-carbon martensitic steels are printed industrially, and printing of tool steels such as H13 is increasing, but even H13 only reaches a hardness of 55 Rockwell C (HRC). Carbide-containing materials possess high hardness but printing these was for long considered impossible, as they tend to crack due to the rapid cooling present in AM processes.

However, as VBN Components demonstrated several years ago, it is possible to print high-carbon materials using Electron Beam Melting. The vacuum environment ensures stable and improved material chemistry, and it is possible to maintain the part at elevated temperature during printing, thereby preventing cracking.

Since then, VBN Components has developed and commercially released five different hard AM materials with extreme wear and heat resistance under the brand name Vibenite®. Their hardness ranges from 55-72 HRC to suit different types of industrial applications and they all contain fine, uniformly distributed carbides in a fine-grained matrix.

The Vibenite® range of high-speed steels (tool steels) contain 7-25 vol% carbides and have hardnesses of 55-72 HRC, with Vibenite® 290 being the world's hardest, commercially available steel. These materials have fatigue properties better than comparable PM-HSS and excellent wear resistance. Vibenite® 350 is a stainless martensitic steel with 20 vol% carbides, a hardness of 60 HRC, good corrosion resistance, and 6-7 times better wear resistance than 316L [1].

Vibenite® 480, the world's first commercially available 3D printed cemented carbide, has 65 vol% carbides, a hardness of 67-70 HRC and excellent thermal stability. Combining the hot hardness of hardmetals with the toughness of HSS, Vibenite® 480 out-performs high Cr white iron in wet wear.

Successful application examples of hard and wear-resistant AM materials from different fields, such as the energy, tooling, and food industry, will be presented. The presentation will also contain some history of VBN and outlook of AM for the future. In addition, a materials surprise will be presented.

[1] E. Iakovakis, E. Avcu, M.J. Roy, M. Gee and A. Matthews, 2022, Scientific Reports 12:12554