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The bellwether of metal 3D-printed aerospace engines: Application technology of the Nickel-based superalloy

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This laboratory is a pioneer research team of a domestic metal 3D-printed Nickel alloy. Because the aerospace engines are difficult to machining, and ordinary laboratories are not competent for the high-temperature performance evaluation of engines. Professor Fei-Yi Hung's team successfully used metal 3D-printed technology to manufacture Nickel alloy aerospace engine components, and conduct investigations on high-temperature mechanical properties and particle erosion characteristics. The research and development results are rich in specifics. They can be applied not only to the aerospace industry but also to electric heating systems for wafer production.

Nickel alloy is a high-temperature material that has corrosion resistance, and be widely used in high-temperature products, such as engines, engines, turbines, boilers, etc., so Nickel alloys are expensive aerospace materials. Furthermore, Nickel alloys have excellent mechanical properties, general clamps cannot test and verify Nickel alloy materials. It is worth noting that National Cheng Kung University Department of Materials Science and Engineering has the rare high-temperature test equipment (temperature up to 700 °C) and high-temperature characteristics investigation ability in the country, which is enough to simulate the actual application of engine turbines.

The chemical composition of Nickel alloys is complex. Both casting and forging have application bottlenecks, the materials need to undergo heat treatment to have sufficient strength and hardness to meet the application level of the aerospace industry. Therefore, it is a very important technical issue to control the crystallization characteristics of Nickel alloys. There is only the material laboratory can have a systematic grasp.

Considering the application of aerospace thrusters, the Nickel alloy engine blades printed by National Cheng Kung University also used particle erosion tests to evaluate the wear behavior of the engine blades. After the team's efforts, two major arguments were confirmed: 1) metal 3D-printed Nickel alloy blades have excellent erosion wear resistance, 2) After the Nickel alloy blade impacted by particles, the material will induce phase transformation behavior and make the surface hardness harder and harder. The publication of this mechanism is also an important milestone.

National Cheng Kung University is one of the few teams in the world that has stepped into 3D-printed Nickel alloys, and it is the first team in the world to publish SCI papers on the erosion wear characteristics of 3D-printed Nickel alloys. It is worthy of admiration in the field of metal and aerospace industries.

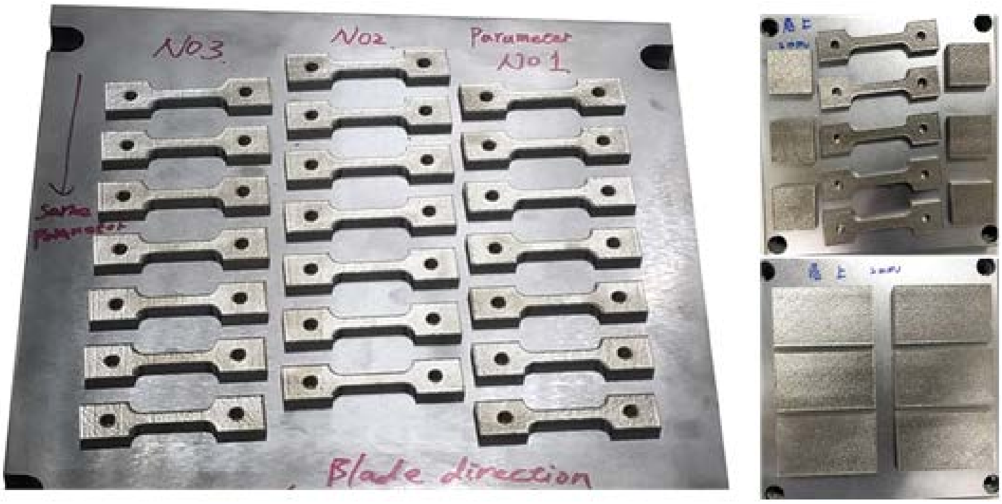

Figure 1. Macroscopic morphology photographs of 3D-printed Nickel alloys specimens.

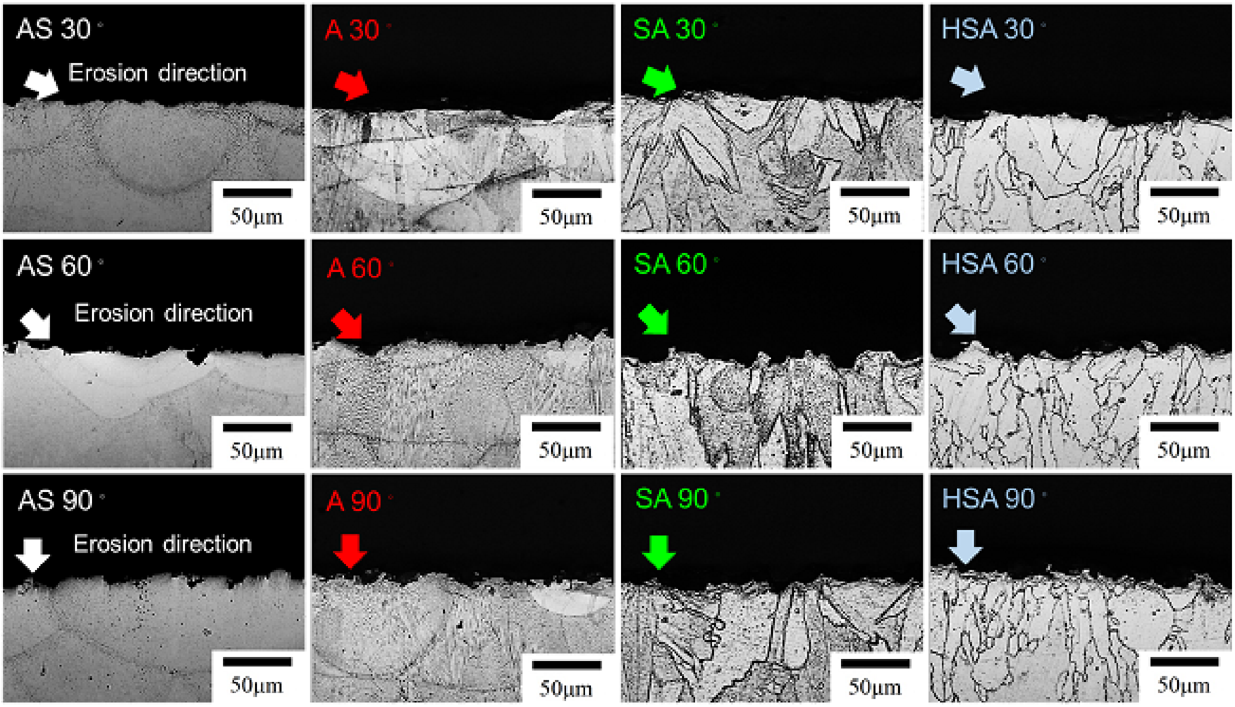

Figure 2. Subsurface morphology of 3D-printed Nickel alloy after particle eroded.

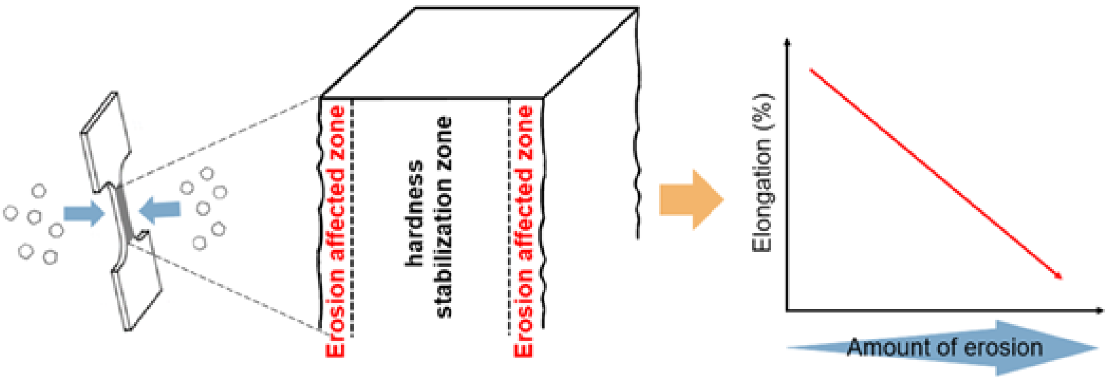

Figure 3. Hardness increase caused by the impact of erosion particles.