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The Design Concept of New Alloys with High Strength and Ductility is Briefly Described

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Abstract: Materials scientists have been constantly on the lookout for ma-terials that simultaneously exhibit high strength and good ductili-ty, which is contrary to common wisdom[1].Earlier attempts to achieve this unusual combination have met with limited suc-cess[2].Novel approaches such as a duplex microstructure con-sisting of nanocrystalline and ultrafine grains yielded encouraging results[3].While the nanocrystalline structure provided high strength, the ultrafine-grained (or relatively coarse-grained) structure provided the needed ductility. In general, the most im-portant concept exploited was to increase the work-hardening ca-pacity of the alloy to increase its ductility, since the former helps in delaying the localized deformation stress (necking) under ten-sion[4].

Keywords: New Alloys; Designing; Ductility; Scientists

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materials scientists have been looking for materials that have both high strength and good toughness, which goes against common sense. Earlier attempts to achieve this unusual combination have had limited success. New methods such as the combination of dual structures of nanocrystals and ultrafine grains have yielded encouraging results.[1]The nanocrystalline structure provides high strength, while the ultra-fine grain (or relatively coarse grain) structure provides the required ductility. In general, the most important concept is to increase the work hardening strength of the alloy in order to increase its ductility, since the work hardening strength helps to retard the local deformation stress (necking) at 10 °C. Fig. 1 microstructure of ag-7 prepared by processing. 5wt% cu-1wt%[2]GE ALLOY: (a) scanning electron micrograph showing coarse equiaxed grains, (b) columnar grains and discontinuous and periodic copper-rich precipitates along the columnar grain boundaries, (C) transmission electron micrographs show discrete copper-rich precipitates arranged periodically. Fig. 2 shows the true stress-true strain curves of casting alloys and cast alloys. [3]Photographs of both samples are shown in the illustrations. Tensile deformable materials scientists have been searching for materials with both high strength and good ductility, which is the collective wisdom. Earlier attempts to achieve this unusual combination have had limited success.[4]New methods such as dual structures consisting of nanocrystals and ultrafine grains have yielded encouraging results. The nanocrystalline structure provides high strength, while the ultra-fine grain (or relatively coarse grain) structure provides the required ductility. In general, the most important concept developed is to increase the work hardening capacity of the alloy to increase its ductility, as the former helps to reduce the local deformation stress (necking) under tension. Ongoing efforts in this area have recently provided another innovative way to obtain high yield strength with good uniform elongation (ductility) in a processable (via Selective laser melting) ag-7. 5wt% cu-1wt% GE alloy. The findings were reported by Mu Shichun, Jan Zelang, Yin Guanchao, and colleagues at the Wuhan University of Technology.[5].Because of the high cooling rate of the alloy during solidification, the microstructure of the alloy is usually complex. The microstructure is fine equiaxed crystal, columnar crystal and coarse equiaxed crystal. In addition, the microstructure of the anisotropy, there are precipitate. Occasionally metastable phases are formed as a result of rapid solidification of the melt. The new feature of the alloy is that cu5ge and cu3ge precipitates along the cell boundary are obtained in the soft-face-centered cubic ag Matrix. The focus of the microstructure studies reported by Wang Et Al. is the periodic formation of precipitates at columnar grain boundaries, which are also twins. Fig. 1A shows the coarse equiaxed grain structure of a typical Scanning electron microscope SLM alloy. Careful observation shows that there are columnar crystals in equiaxed grain 13003, and the precipitates mainly distribute along the columnar grain boundary. Fig. 1B schematically illustrates the columnar structure of SLM alloys and the formation of discontinuous and periodic copper-rich precipitates along the columnar boundary.[9]The actual transmission electron micrograph shows discrete copper-rich precipitates arranged periodically as shown in Fig. 1C. The alloy also contains a variety of defects with high density, such as dislocation, stacking fault/twin and precipitated phase. The tensile mechanical properties of as-cast alloys and SLM alloys show that the yield strength is (175 ± 6) MPA, the strength is (340 ± 8) MPA, and the elongation is (20 ± 0.7)% . The corresponding values of the alloy were (200 ± 5) MPA, (410 ± 3) MPA and (16 ± 0.5)% , which indicated that the alloy had good mechanical properties (Fig. 2) . In the illustration in figure 2, it is noted that there are no necking in SLM alloys. Obviously, the Alloy has higher yield strength (200 ± 5) MPA, but still has better uniform elongation. For a soft silver based alloy, this combination is impressive. The contribution of high

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density defects to the strength of the alloy is about 84 MPA for dislocation, 64 MPA for precipitation, 22 MPA for grain refinement and stacking fault/twin. Although the mechanical properties of SLM alloys have been improved, it should be noted that there is no obvious necking at fracture. The results show that the theoretical strength and plasticity of the alloy should reach 545mpa and 50% respectively. However, low-value experimental measurements indicate that premature failure occurs in this alloy.[8]The present study is the first attempt to explore the premature failure of alloys in SLM processing. The results show that the strain hardening index of the alloy is higher than that of as-cast Alloy. The higher values in the former are due to the presence of high-density internal defects, discontinuous precipitates and graded structures (feedback stress)[6-7].Explanations for premature failure include internal factors (high dislocation density) and external factors (such as the presence of unmelted particles, improper laser irradiation of the powder bed, and porosity/voids (which may be due to gas adsorption on the powder particles, improper process parameters, and improper laser irradiation of the powder),which are weaknesses that ultimately lead to premature failure. Once measures are taken to alleviate these problems, it is possible to obtain unprecedented mechanical properties in terms of strength and ductility, thus opening up a new way to develop ductile high strength alloys through 3D printing. In order to develop the new material industry,the state gives strong support in policy. Up to now, the state has passed the high tech new materials, National Science and Technology Research Program, Torch Program, 863 Program, Program 973, the National Natural Science Fund; Seven projects, such as the SME Innovation Fund, strongly support the development of the new materials industry. At the same time, the state has also increased funding support for scientific and technological research in the new material industry, with an annual investment of more than 500 million yuan. Zhang Guobao, deputy director of the National Development and Reform Commission, said that macro guidance should be strengthened and policy support strengthened to recognize, focus on and give priority to the development of the new materials industry from a strategic perspective. Zhang Guobao stressed that although China's new materials industry has made great progress, but compared with developed countries, the overall level of new materials there is still a big gap. The macro guidance and policy guidance of the state will play an important role in guiding the R & D, industrialization and large-scale production of new materials. It is necessary to establish a mechanism of innovation and industrialization in which the market and demand are closely linked in terms of policy, to strengthen the innovation capacity within the industrialization of new materials, to stimulate the use of social resources to carry out innovation activities and to optimize the allocation of resources, we will break through the technical bottlenecks in the engineering and industrialization of new materials, set up the development goals of the materials science, attach importance to the formation of core industrialization and industrial chains, and realize the supporting of related industries in the upstream, middle and downstream areas, and realize industrialization on a large scale. All these measures, to promote and accelerate the development of China's new materials industry has had a major impact. China's new material industry has thus entered a period of rapid development.

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