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Texture evolution for multilayer steel with multi-scale heterogeneous structure after various tensile deformation

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Abstract: Conventional strengthening metals always has the disadvantage of sacrificing ductility and toughness, so improving the comprehensive mechanical properties of metals have been the focus of research. In this work, CoCrNi/Maraging multilayer metals with strong interfaces and two-scale grain structures are prepared to achieve a significant enhancement of strength (~1800MPa) and fracture elongation (~20%). The differences in the deformation texture evolution of CoCrNi alloy and Maraging steel components at different tensile strain are analyzed by neutron diffraction experiments to reveal the plastic deformation coordination and strengthening-toughening mechanism of multilayer metals.

Keywords：neutron diffraction, texture analysis, multilayer steels, laminate/network structure

１. Research Purposes

Neutron diffraction technique is used to study the connection between the plastic deformation behavior of bcc and fcc metals, to reveal the strain-stress partition and deformation coordination of multilayer metals, to break through the premature fracture failure of the traditional multilayer steels with severe plastic instability. It can provide new design ideas for the multilevel and multiscale heterogeneous organization construction of metallic materials.

２. Experimental Procedures

The deformation textures of aged CoCrNi/Maraging multilayer metals during various tensile strain 0%, 10% and 15%, were measured using RESA neutron diffraction at JRR-3. The 10×10×10 mm^3 samples are prepared, and put its RD direction parallel with diffraction direction. In addition, conventional microstructure analysis techniques such as transmission electron microscopy (TEM) and in-situ electron backscatter diffraction (EBSD) were here employed complementarily. The neutron diffraction results were analyzed using the MAUD texture software.

３. Results and discussion

The results obtained from neutron diffraction clearly demonstrate distinct texture evolution in the CoCrNi/Maraging multilayer metals during tensile process. Fig. 1 displays the (110)α, (111)γ, (200)γ, (200)α, (220)γ and (211)α pole figures of CoCrNi/Maraging multilayer metals with different tensile strain. In Fig. 1(a), the CoCrNi layer shows weak {123}<634> and {123}<634> texture, while C350 maraging steel shows weak {112}<110>, {111}<112>, and {100}<110> texture without tensile deformation. It is worth noting that after different tensile strain of 10% and 15% (Fig. 1(b) and 1(c)), the texture type of CoCrNi layer has changed significantly, especially {110}<112> brass texture and {110}<001> Goss texture, while the texture characteristics of C350 layer are almost unchanged. Meanwhile, the texture intensity is enhanced with the increase of tensile strain. Actually, although the yield strength, ultimate strength, strain hardening and plastic defomation behavior of CoCrNi and C350 maraging steel layer are entirely different, the deformation coordination of CoCrNi/Maraging multilayer metals is rather uniform without obvious periodic necking, tunnel crack and interface delamination, which may be attributed to the localized plastic instability can be delayed by the high strain hardening capacity of CoCrNi layer with low fault stacking energy, resulting into the formation of hardened Brass texture.

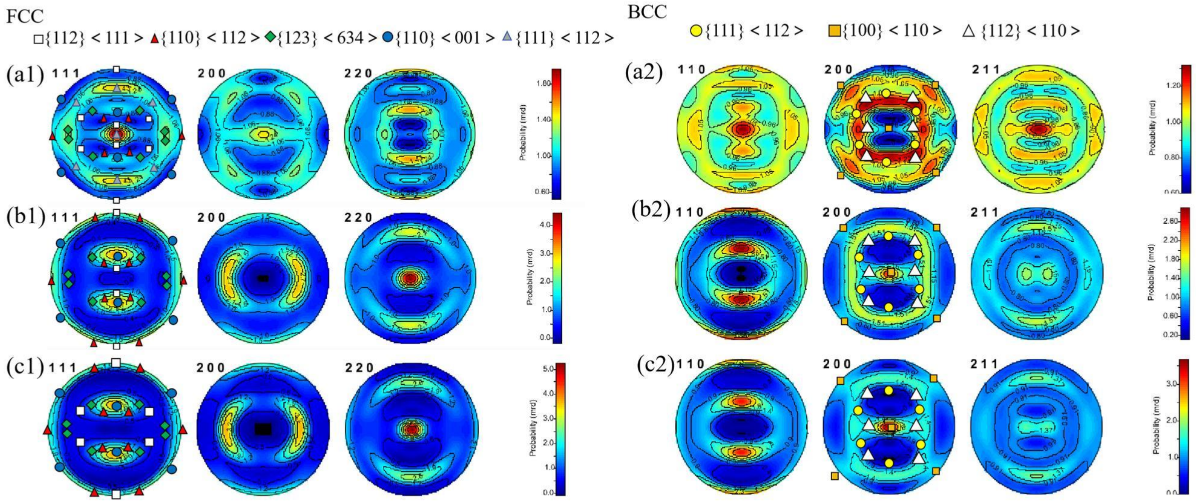

Fig. 1. (110)α, (111)γ, (200)γ, (200)α, (220)γ and (211)α pole figures of CoCrNi/C350 multilayer metals with tensile strain. (a1, a2) 0%, (b1, b2) 10%, (c1, c2) 15%.

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