Texture evaluation for heterogeneous multilayer metals with different interface structures after various tensile deformation

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Abstract: BCC/FCC multilayer steels always behave severe strain localization and interface instability during the plastic forming and deformation process, such as tensile testing and rolling process. The above deformation incoordination behavior exhibits unique topological structure: hard FCC layer reveals multiple periodic necking instability, while soft BCC layer reveals uniform layer thickness, leading to the formation of laminate/network structure, which is similar as the Damascus pattern of warm folding forged Japaneses amurai sword. The interface instability may be closely related to the difference of deformation texture and dislocation pattern between the FCC and BCC layer, leading to the rather different strain hardening capacity and deformation characteristics. In this work, neutron diffraction experiments were used to investigate the texture evolution during the hot, warm and cold rolling process, in order to clarify the interface instability and laminate/network structure formation mechanism of multilayer steel during the plastic forming.

key words: multilayer steels, neutron diffraction, deformation texture, laminate/network structure, interface instability.

1. Objectives

Neutron diffraction technique is used to investigate the difference of deformation texture and plastic deformation behavior between bcc and fcc steel layers, in order to reveal the formation mechanism of laminate/network structure of multilayer steel, which can break through the limitations of the traditional multilayer steels in terms of flat interfaces and single-structure toughening. It can also provide a new design idea for the multilevel and multiscale heterogeneous metallic materials.

2. Methods

The deformation textures of SUS304/Q235 multilayer steels during various rolling parameters, 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 SUS304/Q235 multilayer steels during various rolling parameters. Fig. 1 displays the $(110)_\alpha$, $(111)_\gamma$, $(200)_\gamma$, $(200)_\alpha$, $(220)_\gamma$ and $(211)_\alpha$ pole figures of SUS304/Q235 multilayer steels during the hot/warm/cold rolling processes, respectively. In Fig. 1(a), the hot-rolled SUS304 layer has a slight brass texture. The warm-rolled SUS304 contains many high intensity of deformation texture, such as brass texture and S texture (Fig. 1(b)), while the copper-type texture is absent, which may be attributed to the transition behavior from copper-type to brass-type texture during the warm rolling process. Actually, the SUS304 layer with brass-type texture is prone to induce the severe shear bands and strain localization, leading to the interface instability and periodic necking. In addition, the hot-rolled Q235 layer has an initial orientation with {100}<110> texture, as shown in Fig. 1(c). Herein, the orientation of Q235 layer changes into the high intensity of {111}<112> texture (Fig. 1(d)).

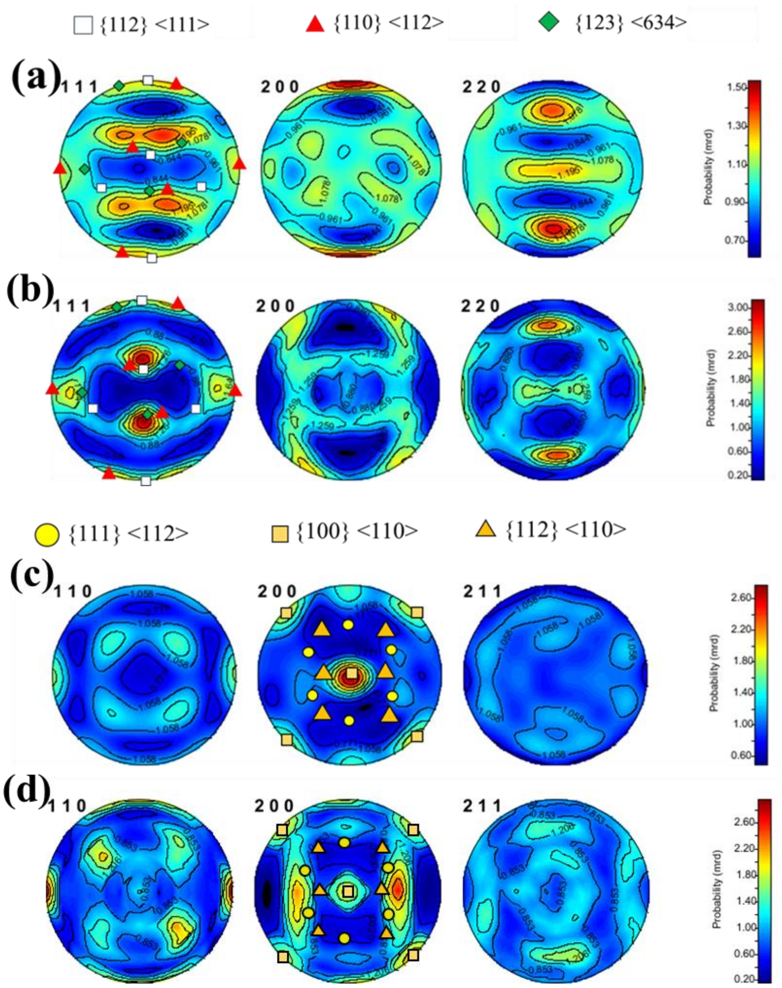

Fig. 1. (110)α, (111)γ, (200)γ, (200)α, (220)γ and (211)α pole figures of SUS304/Q235 multilayer steels with different rolling parameters. Hot rolling, 75%: (a) SUS304 layer, (c) Q235 layer; Warm rolling, 75%: (b)SUS304 layer, (d) Q235 layer.

4. References

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