Study on residual stress and texture through thickness of Al alloys plate by short wave length characteristic X-ray diffract-meter in nondestructive way

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Al alloy thick plates are easy to deformation when being heat treated and produced due to internal residual stress. When plates are welded, the residual stress in weld zone will redistributed. Control or decrease the stress ladder distribution through thickness will be very helpful for industry. However, measuring the residual stress through the thickness of thick plate without any destructive is a difficulty test. Conventional X-ray such as Cr Kα adopted in X-ray stress-analyzer has not enough power to penetrate beyond 0.2 mm thick plates. Only neutron diffraction or synchronic radiation’s hard X-ray diffraction, which occupy large area and need huge investment, can be competent to do it. Here a new short wave-length characteristic X-ray diffraction-meter (SWXRD) has been invented by Institute of Southwest Engineering Technology in China. The principle of operation has been introduced in this paper. The W Kα of tungsten target X-ray tube was used which allows it penetrate 20 mm thick plates of Al alloy. The special light path has been designed to assure that the W Kα diffraction signal at fixed point can be got through thickness. Residual stress profile in the middle layer of friction stirring weld (FSW) of 12.5 mm thick plate has been got (Fig.2). For decreasing residual stress in pre-stretched plates, the distribution of internal residual stress and texture had been measured non-destructively for 25 mm thick 2024 and 20 mm thick 7075 pre-stretched plate. The result of residual stress distribution in 7075 alloy by SWXRD has been compared with that by neutron diffraction in LLB. The results show that the SWXRD can be used to measure residual stress and texture in Al alloy thick plate effectively. It can be extended to measure Mg alloys, Ti alloys etc. light alloys or crystal materials, however, more research should be conducted in the future.

Fig.1 Sketch of principle of SWXRD

Fig.2 Residual stress profile in middle layer of 7075 Al alloys FSW joint

**Key words:** short wave-length X-ray, residual stress, Al alloy plate, non-destructive test

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