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利用PIV技术对非光滑表面湍流边界层的实验研究

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PIV STUDY OF NON-PLANAR SURFACE TURBULENT BOUNDARY LAYERS

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摘要 利用在线式 P I V 系统在低速风洞中对两种非光滑表面：阵列涡发生器表面和波纹壁面的湍流边界层进行了实验测量。观察到了壁面几何形状的改变对非光滑表面湍流边界层拟序结构的产生和发展的影响：阵列涡发生器表面（１０ｍ／ｓ）湍流边界层内有明显的双剪切带状结构，外剪切带状结构接近边界层的外边界，小尺度的涡在内剪切带状结构的附近产生；波纹壁面（２０ｍ／ｓ）湍流边界层内涡的尺度比较小。并在相同的壁面几何形状条件下，在不同的流动工况下，研究了非光滑表面对湍流边界层拟序结构的影响。实验结果表明，壁面几何形状的改变对外层的大尺度横向涡的产生和发展有明显的影响；而这种影响效果在不同的流动工况下相差很大。

关键词： 湍流边界层 剪切层 PIV

Abstract： Detailed 2D flow fields in low speed wind tunnels are measured with on-line PIV to study the flow structures in the zero-pressure gradient turbulent boundary layer of two non-planar surfaces: the vortex generator surface and the wavy surface. Some typical coherent structures are identified from instantaneous streamwise wall-normal velocity fields, from which vorticity and strain rate fields are also calculated. The influence of flow speed on flow structures in the turbulent boundary layer is investigated. Two distinct and regular shear layers are observed in the boundary layer for the vortex generator surface at 10m/s. The small-scale vortices are generated near the inner shear layer. The wavy surface (at 20m/s) will generate smaller scale vortex than the smooth plate. It is shown that wall surface geometrical structure can greatly influence the generation and development of large-scale transverse vortex. This effect varies significantly with different flow conditions.

Keywords： turbulent boundary layer shear layer P IV

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