Features of laminar-turbulent transition of adverse pressure gradient flows at low and high Reynolds numbers

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Recent experimental studies of laminar-turbulent transition are presented with focus on adverse pressure gradient flows. New developments in secondary instability of streaks and separation control are reported. In the first part of the presentation the studies of laminar-turbulent transition in non-swept and swept wing boundary layers are discussed, and in the second part the investigations of separated flows on wings with ordinary (plain) and modified (wavy-shaped) surfaces are considered. The role of three-dimensional velocity perturbations such as streamwise vortices and streaks in the laminar-turbulence transition process is demonstrated, and the importance of secondary instability mechanisms is outlined. For a straight wing, the experimental studies of the nonlinear varicose secondary instability are compared at zero and adverse streamwise pressure gradients. Results obtained testify to the strong influence of the pressure gradient upon the breakdown of streaks with developed instability[1]. For the swept wings, the stationary vortex packets are most likely to be generated under natural flight conditions and transition to turbulence is known to be the quickest within these disturbances. Two modes of the secondary instability are found to develop and the preferred mode is dependent on the properties of the primary stationary disturbance. The instability modes studied are the '*y*' and '*z*' high-frequency secondary instability modes, which are investigated separately and also their interaction under fully controlled experimental conditions[2]. Furthermore, the influence of wing surface modifications on the wing performance and drag is studied. The results testify that for the low-Reynolds-number flow conditions the critical angle of attack of a wing with a wavy-shaped surface can be up to 1.5 times or more than that of a similar plane-surface-wing, and for the attack angles in the range between 5 and 20 degrees the wing with a modified surface reveal higher aerodynamic quality owing to decreased size of the separated zones[3].

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