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传递现象

梯度表面能材料表面上滴状凝结换热

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摘要 采用气相沉积（CVD）的方法，以十二烷基三氯硅烷和辛基三氯硅烷为扩散工质，制备了梯度表面能材料表面。对空气中水滴在水平梯度表面能材料表面上的运动现象和表面倾角为0°、30°、60°和90°情况下，梯度表面能材料表面上的水蒸气滴状凝结换热进行了可视化实验，研究了凝结液滴的长大、聚并、运动和脱落现象。结果表明：直径大于1 mm的凝结液滴峰值运动速度达到110 mm·s-1 ，远大于空气中液滴的运动速度。通过图像分析，分别讨论了壁面过冷度、凝结表面倾角和表面能梯度对换热和液滴运动的影响。结果表明：随着壁面过冷度的增加，凝结表面传热系数先增加后减小；当凝结表面倾角大时，由于重力作用加大，凝结表面传热系数也高；当表面能梯度较大时，运动液滴尺寸更小，速度更快，凝结表面传热系数更高。

关键词 梯度表面能材料表面；滴状凝结；可视化

分类号

Dropwise condensation heat transfer on surface with gradient surface energy

Abstract

By using the chemical vapor deposition（CVD）technology，two testing surfaces with gradient surface energy were fabricated on a base of silicon wafer with dodecyltrichlorosilane and octrytrichlorosilane respectively.Using a high-speed video imaging system，the movement of water drop on the horizontal surface with gradient surface energy was visualized and measured under ambient condition.The heat transfer experiments were conducted on dropwise condensation of steam on the surfaces with gradient surface energy.During experiments，the condensing surface was placed at inclination angles of 0°，30°，60° and 90°，respectively.The growth，coalescence，motion，and abscission of condensed droplets were visualized by the high-speed video imaging system.The observed results showed that the condensed droplets larger than about 1 mm in diameter could move at a peak speed of 110 mm·s-1 from hydrophobic side to hydrophilic side on the horizontal condensing surface with gradient surface energy.The velocity of condensed droplet was far larger than that of the droplet on the surface with gradient surface energy in ambient atmosphere.The effects of heat transfer temperature difference，inclination angle of condensing surface，and surface energy gradient on the condensation heat transfer were respectively discussed in virtue of the photographic results.The experimental results showed that with an increase of heat transfer temperature difference，heat transfer coefficient increased to a maximum value and then decreased afterwards.As the inclination angle of condensing surface increased，the condensation heat transfer coefficient increased due to the action of gravity on the departure and motion of droplet.A larger surface energy gradient led to a smaller departure diameter and a faster motion of droplet，which resulted in a larger condensation heat transfer coefficient.

Key words surface with gradient surface energy；dropwise condensation；visualization

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