A NEW METHOD OF FABRICATION OF HEAT TRANSFER SURFACES WITH MICRO-STRUCTURED PROFILE

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The present invention relates to the art of improving heat transfer from heated tube surfaces to boiling liquids. By the technique of ion track membranes and microgalvanic method microstructures like copper whiskers with high aspect ratio can be produced on surfaces of heat transfer tubes fig1. [1], New experimental results show that the capillary-porous microstructure causes a large heat transfer from the surface material to the liquid, see fig.2. The experimental set-up consists of glass flasks which allows to observe the boiling process of the liquid on tube surfaces (fig.2). The liquid R365, a new product of SOLVAY Company, was used to study the growing process of vapour bubbles on tube surfaces with copper whiskers with a high aspect ratio and a density of $10^5$ per cm$^2$. Varying the temperature of water going through the tube the heat flux of the boiling process was measured (fig 2,3,4).

Fig 1. The scheme illustrating the fabrication of the heat transfer tube. Polycarbonate foil is irradiated by heavy ions and etched afterwards to produce a porous membrane, the so-called ion track membrane. The membrane is wrapped around the copper tube that serves as a cathode in the galvanic cell. The subsequent deposition process fills the pores with copper. An array of copper whiskers is created on the tube surface after dissolving the membrane.

Fig 2. The scheme of the experiments on the heat transfer. Heated water is pumped through the tubes. Due to the boiling process outside the tube the temperature of the water decreases.
Fig. 4. The heat flux as a function of the overheat temperature $\Delta T=T_{\text{water}}-T_{\text{vapour}}$ (bottom). The heat transfer coefficient ($k$-value) as a function of the heat flux (top).

Fig. 3. The heat exchange tube with the microstructured surface. The tube is characterized by: 1. high surface area, 2. large volume of microcavities, 3. tight contact between the tube body and the array of whiskers.

References