CHAPTER I

INTRODUCTION

The increasing power dissipation and miniaturization of microelectronic circuits drive extensive studies on high performance cooling systems. Such systems are often based on evaporative cooling processes in micro heat pipes, capillary pumped loops and spray cooling devices. In most of these systems the wall is only partly flooded with a macroscopic liquid layer, and the flow pattern is characterized by the presence of 3-phase contact lines. The 3-phase contact line is defined as the interaction between a thin film of liquid, its vapor, and a solid surface. A common and important heat transfer mechanism in these cooling systems is evaporation of ultrathin liquid films in the vicinity of 3-phase contact line accompanied by extremely high heat fluxes. Understanding the phase change phenomena in the 3-phase contact line region is important for optimizing the evaporative cooling processes [1].

1.1 Introduction to 2-phase Heat Transfer.

2-Phase heat transfer like nucleate boiling has traditionally been used to dissipate energy in high-heat-flux applications because of high value of latent heat of vaporization compared to the heat transfer coefficients for convection and conduction. However, industrial demands for more efficient heat transfer have grown rapidly in recent years.

1.2 Introduction to 3-phase Contact Line.

The intermolecular interactions between a thin film of liquid, its vapor, and a solid surface called ‘‘microregion’’[1], A considerable amount of the total heat supplied to the system passes through a tiny thin liquid film area where the liquid-vapor interface approaches the wall material see Fig.1.1, the curvature of the liquid–vapor interface differs strongly from the mean curvature in the bulk of the liquid (‘‘macroregion’’). Adhesion forces between liquid and wall cause a steady transition of the meniscus into a flat adsorbed, non-evaporating film. The curvature change and the adhesion forces cause a pressure gradient in the liquid that leads to a transverse liquid flow from the bulk of the liquid to the thin film region. In the microregion, between the adsorbed, non-evaporating film and the macro region with a high conductive heat resistance, very high local heat fluxes and evaporation rates can occur.

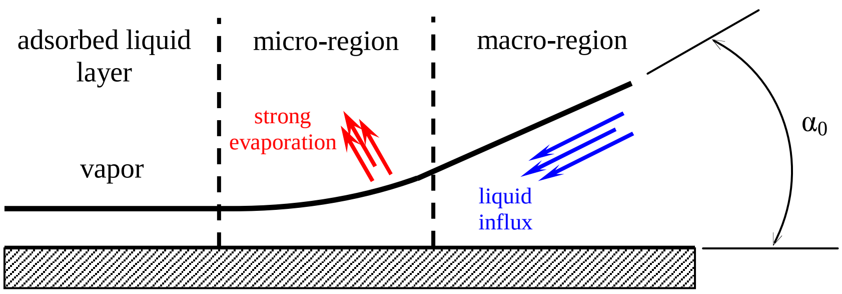

Figure 1.1. Micro -region model [1]

1.3 Problem Definition and Objectives.

It is important to understand the thin film evaporation near the 3-phase contact line. This Understanding will help in optimizing the evaporative cooling processes in the high performance heat transfer applications such as heat pipes and spray cooling, etc. The full understanding of the relevant microscale heat and mass transport phenomena has not been yet achieved.

The aim of the present work is to contribute in the fundamental understanding of the various thermodynamic phenomena in the 3-phase contact line region. It is focused on the experimental measurement of the heat flux and temperature distribution of the heated wall with high spatial and temporal resolution. This allows investigating the heat transfer mechanisms at the 3-phase contact line. Which will be useful in identify the role of evaporation at the 3-phase contact line and to prove it experimentally since numerical and theoretical models predict a significant portion of the latent heat transferred through this tiny part of the 3-phase contact line.