Highlights from european journals

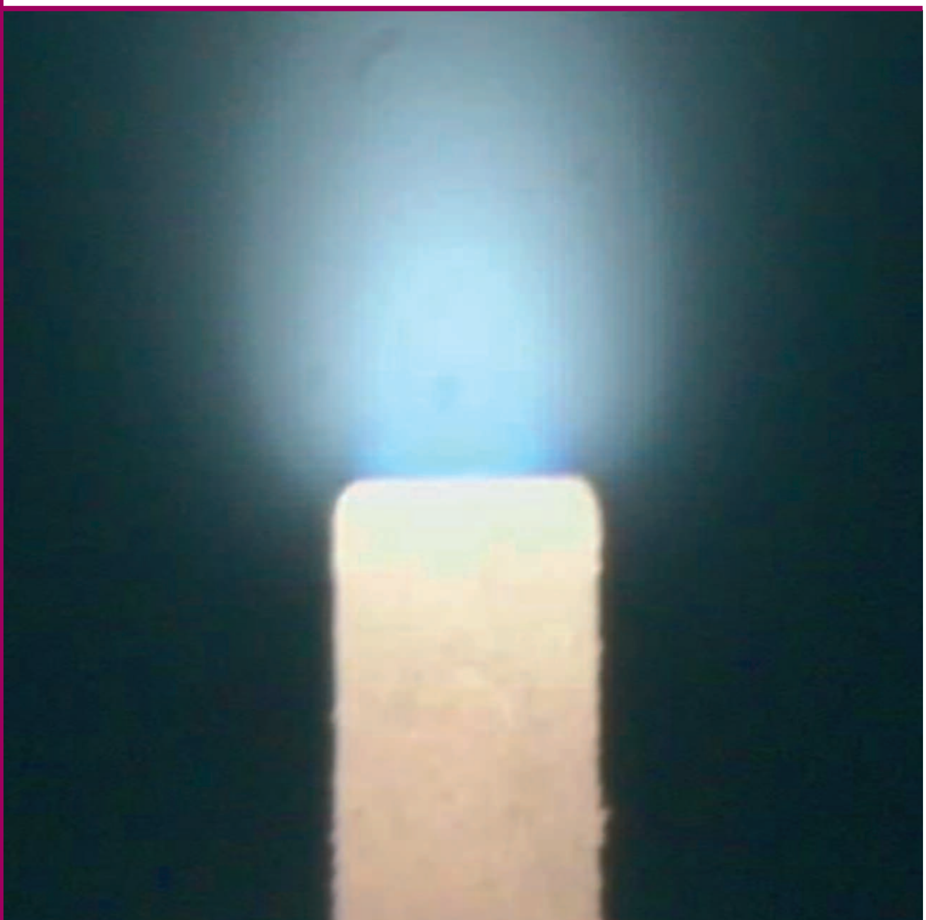
Some light on electric arcs

The electric arc was discovered only shortly after the first electric power sources became available in the early 19th century. Today, electric arcs are used for various purposes in science, industry and everyday life (e.g. as light sources, circuit breakers, etc.) However, the physical phenomena are still not fully understood. Crucial for both an understanding of the underlying physics and the improvement of commercial applications are the transition layers between the electrodes and the arc plasma. For fundamental research, we have developed a prototype free-burning arc discharge serving as a model for high intensity discharge (HID) lamps. These lamps are used in many ways including video beamers, cinema projectors and automotive headlights.

The discharge is operated in argon under atmospheric pressure and uses cathodes with a diameter of 0.6mm. Besides a corresponding high spatial resolution to overcome the large gradients in temperature and particle density, one needs to be aware of the deviations from the state of local thermodynamic equilibrium (LTE) in the near-cathode region. In this paper we present spatially resolved spectroscopic measurements of the electron density, the electron temperature and (for the first time) of non-LTE parameters as the gas temperature. The evaluation of the data obtained by (passive) quantitative plasma spectroscopy and (active) power-interruption experiments is based on a plasma model for partial thermodynamic equilibrium (pLTE). ■

G. Kühn and M. Kock,
J. Phys. D: Appl. Phys. 39, 1 (2006),
"A spatially resolved relaxation method for pLTE plasma diagnostics in free-burning arcs".

▼ The hot core region of the arc discharge. The cathode consists of thoriated tungsten and is 0.6mm in diameter. The blue plasma region in front of it features peak electron temperatures above 20000K.



Wetting or not wetting?

The importance of surfaces in condensed matter physics was acknowledged recurringly throughout the last century, during which a plethora of problems were tackled and, some of them, solved. One of the most obstinate problems in the list is related to the surface properties of the Ising model, in particular the nature of its wetting transition. Quite generally, this phase transition occurs when one of two coexisting phases (think liquid and vapour) is energetically preferred by the confining walls of the system. Far from being a technical detail, the wetting transition has deep implications since it is intrinsically linked to the vanishing of the contact angle formed by the drop of one of the phases (liquid, say). The hard question is "Does the wetting transition occur continuously or abruptly?", or in jargon, "What is the order of the wetting transition for the three dimensional Ising model?". This problem is particularly appealing since the dimension d=3 is the marginal case separating the mean-field regime (d>3) from the fluctuation dominated regime (d<3), and the influence of fluctuations is not an easy matter to assess.

An exact solution of the 3D Ising model is, of course, prohibitively difficult and theorists have resorted to coarse-grained descriptions based on "interfacial models" characterised by a surface tension and an effective potential W. The predictions of this coarse-grained treatment are, however, completely at odds with simulation studies of the Ising model.

In the present paper, we derive a coarse-grained description which appears to consistently resolve this, and other controversies. In this theory, the potential W has an elegant diagrammatic representation

$W = a_1$  $+ b_1$  $+ \cdots$

which accounts for missing physics in the original interfacial description and allows one to "see" the shape of a free-energy.

The model also opens the door to more systematic studies of wetting at micro-patterned and sculpted substrates, relevant to nano-fluidics, which were not possible in previous descriptions. ■

A.O. Parry, C. Rascón, N.R. Bernardino & J.M. Romero-Enrique,
J. Phys.: Condensed Matter 18, 6433 (2006),
"Derivation of a non-local interfacial Hamiltonian for short-ranged wetting 1: Double-parabola approximation".