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DIGITAL HOLOGRAPHIC INTERFEROMETRY EXPERIMENTAL SETUP TO STUDY MASS TRANSFER PROCESSES

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For many years, holographic interferometry (HI) has been an optical method widely used to study mass transfer processes in liquids and in transparent gels. During an experiment, changes in the refractive index distribution, and therefore in the concentration distribution, are visualized as an interference fringe pattern (the interferogram).

In real-time HI, the first step is to obtain the hologram: an image of the object at a certain time (the reference state), holographically stored, and usually recorded on a holographic plate by a photographic method. The second step is to obtain the interferograms at different times. Combining the current object wave with the reference object wave stored in the hologram, the interferogram (the fringe pattern) is obtained.

A major drawback of classical HI is not so much the cost of the holographic plates but the difficulty in developing the film. Moreover, all the interferograms are obtained by comparing the current state of the object with the only hologram taken. Therefore, the temporal states that are compared cannot be freely chosen. These problems have been overcome by using digital holographic interferometry (DHI). Digital holography (DH) is the digital recording and numerical reconstruction of numerous holograms and it offers the possibility of combining the current object wave with reference waves captured at different times. In DH, the holographic plate is replaced by a digital CCD (Charged Coupled Device) camera, which records the hologram.

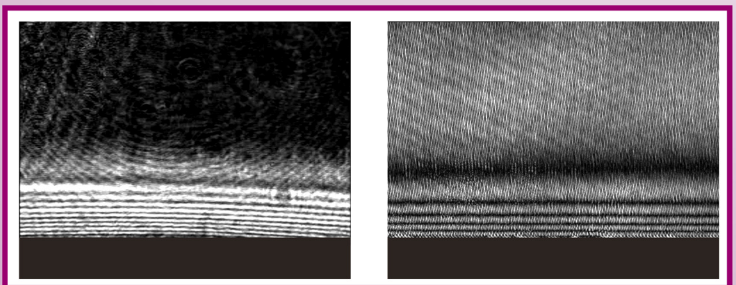


Figure 2. Different interferograms of a Reverse Osmosis polarized layer obtained with classical HI (left) and with Digital HI (right)

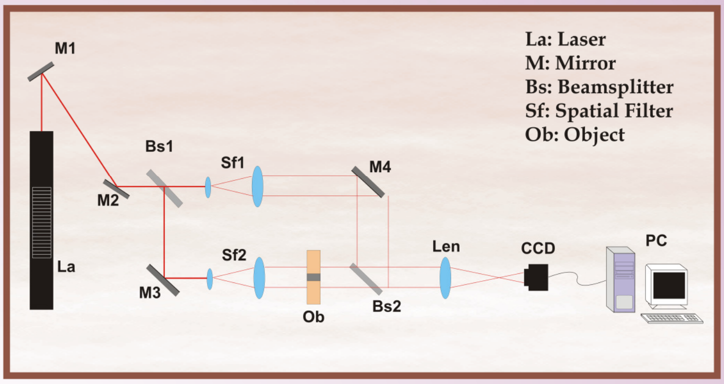
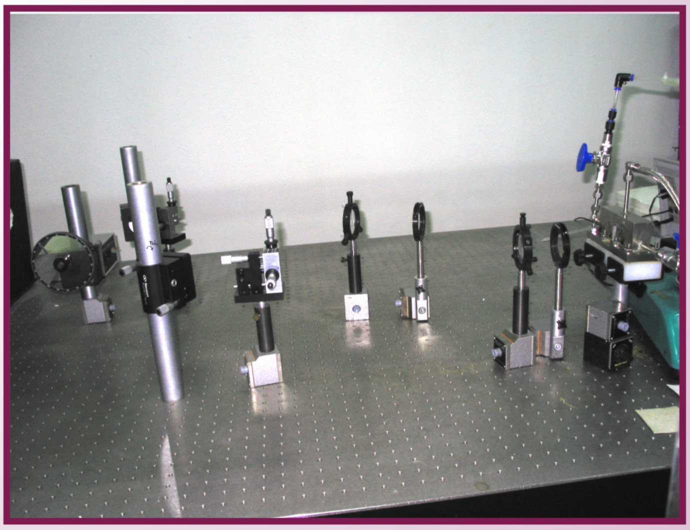


Figure 1. Set-up for Digital Holographic Interferometry



The classical HI setup previously used to study mass transfer processes has been modified to adapt it to the DHI (figure 1). Laser beam is divided in two beams by a beamsplitter. After passing through the object, the object beam is again joined with the reference beam and both together interfere on the CCD camera, where the hologram is digitized. Furthermore, in order to capture and to reconstruct numerically the holograms, a MATLAB program has been developed.

The new technique was checked by comparing the results from interfograms obtained in diffusion and reverse osmosis experiments with HI and DHI. A good agreement was obtained. Fringes obtained by the digital method were sharper tan those obtained with with the HI method (figure 2).