commercial production has suffered from inadequacies in process monitoring and control. A key process parameter is the SSM solid-liquid fraction, which is a sensitive indicator of the deformation and flow behavior of the material during forming. Unfortunately, no sensor currently exists to provide an in-situ measurement of this important parameter. Here we present preliminary results for an advanced ultrasonic sensor to measure solid fraction. With the aid of metal alloy phase diagrams the binary alloy Sn-Bi was chosen to simulate behavior of Al/Si (e.g. 300 series) alloys. The phase diagram was used to provide the value of solid fraction at any given temperature. Measurements with longitudinal ultrasonic waves at 1 MHz in the selected alloy heated to different solid fractions were performed with a combination of commercial transducers and quartz buffers penetrating into a temperature controlled furnace. Five compositions were used ranging from 83% to 100% -Bi in the binary Sn-Bi alloy. Presented are measurements of longitudinal wave velocity as a function of temperature across the entire range from totally solid to semi-solid to liquid states in both heating and cooling runs. The curves show the characteristic phase transitions. A quasi-static viscoelastic model based on Atkinson, Kytomaa and Berryman was prepared and modified for the SSM application. The comparison of the model calculations with the experimental results were in reasonable agreement. With the recent development of high temperature ultrasonics our results provide a potential solution to the development of an ultrasonic sensor for SSM.

3K-6 5:45 p.m.

ACOUSTICAL AND OPTICAL CHARACTERIZATION OF AIR ENTRAPMENT IN PIEZO-DRIVEN INKJET PRINTHEADS.

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Air entrapment leads to malfunctioning of jet formation in a piezo-driven inkjet printhead. The entrapped air bubbles disturb the acoustics and in many cases cause the droplet formation to stop.

Here we will focus on piezo-electric inkjet devices where a voltage pulse applied to a piezo-electric element causes an ink-filled channel to deform, thereby creating a pressure waveform in the ink. Fluid acoustics are involved to guide the waveform energy towards the nozzle, and to create pressure and velocity profiles needed for the droplet jetting process. Droplets are jetted every 50 μs and it is essential that the droplet formation remains stable for an extensive period. Though the droplet forming process is very stable for literally millions of droplets, from one to the next actuation cycle there may be an occurrence giving rise to a malfunctioning of the droplet formation. A notorious problem in piezo-acoustic inkjet systems is the formation of air bubbles during operation. Here

we detect air entrapment, reveal the air entrapment process, and the time evolution of the entrapped air bubble.

The acoustical signal is monitored by using the piezo actuator as a sensor to measure the pressure in the channel after the pulse is applied. The optical measurements are performed with a range of high speed imaging cameras up to 1 Mfps, including the Brandaris 128 camera system [1]. The nozzle diameter is 30 μm or less. Typically the firing frequency is 20 kHz.

When a droplet is fired correctly, the acoustical signal is perfectly reproducible. The variations in the amplitudes of the signals stays well within 0.1%. This signal is employed to monitor deviations in the droplet formation and to trigger the optical setup. In particular, it detects the presence of an air bubble inside the ink channel, as an air bubble modifies the acoustical signal in a characteristic way. Once entrapped, the air bubble has an initial radius of 10 μm and oscillates with a frequency near 200 kHz. The radial growth of the bubble is found to be 0.3 μm/ms and the bubble reaches velocities up to 20 mm/s inside the ink channel.

In conclusion, the acoustical signals from the piezo actuator can be used to detect air bubbles inside the printhead and disturbances, which can result in air entrapment at the nozzle. The optical results will be implemented in numerical and theoretical models for entrapped bubble growth, displacement and oscillations.

[1] C.T. Chin et al, Brandaris 128: a 25 million frames per second digital camera with 128 highly sensitive frames. Review of Scientific Instruments, 74, 5026-5034 (2003).

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Session: 4K

PHYSICAL ACOUSTICS III
Chair: M. Fink
ESPCI-Universite-Paris VII

4K-1 4:30 p.m.

NEW METHOD OF CHANGE IN TEMPERATURE COEFFICIENT DELAY OF ACOUSTIC WAVES IN THIN PIEZOELECTRIC PLATES.

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As is well known the coefficient of electromechanical coupling (K^2) and temperature coefficient of delay (TCD) of acoustic wave are very important for development of various acoustic devices and sensors. One of the modern lines