In-line measurement of velocity synchronization between contact surfaces in offset printing

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Extended Abstract :

Recently, next-generation patterning process is actively studied to replace the photo-lithographic process and reduce the production cost. For micron scale patterning, the printing process is one of major candidates.[1)] Especially, contact printing is more promising in view of mass production.

In contact printing, the motion of both printing contact surfaces should be synchronized perfectly to prevent slip and un-wanted distortion in contact surfaces and to make precise ink transfer between surfaces. For example, in the gravure offset printing process which is shown in Fig. 1, ink should be accurately transferred from the master plate to the blanket roll and from the blanket roll to the substrate as the nip is moving with the rotary motion of the blanket roll and the linear motion of the master plate and substrate. Figure 2 shows the exaggerated view of ink transfer in the nip. If there is slip between contact surfaces within the nip, the printed patterns may be blurred or distorted.

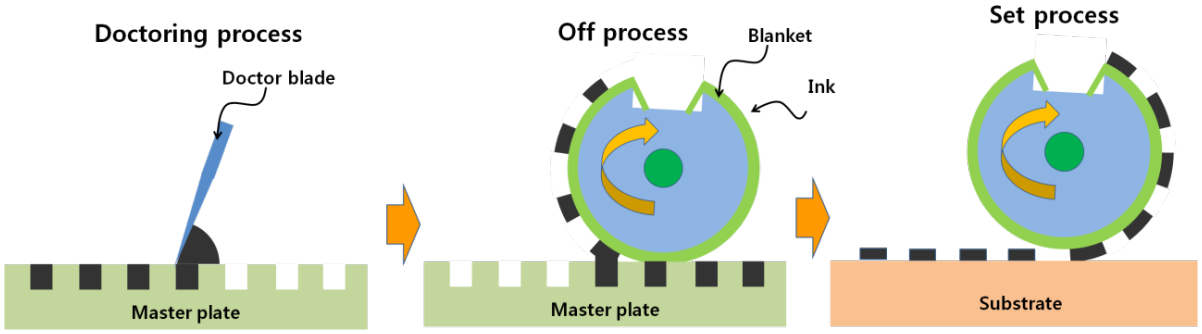

Fig. 1 Concept of the gravure offset printing process

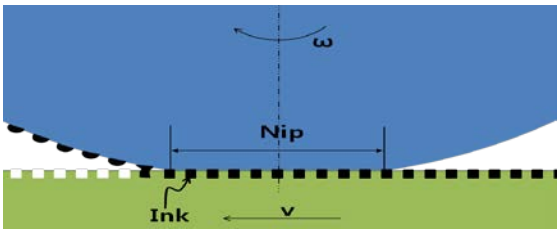

Fig. 2 Ink transfer from the master plate to the blanket roll in the gravure offset printing process

In this article, the friction force based in-line measurement method of the synchronization velocity error is proposed. Because the synchronization error causes the friction force between contact surfaces, the synchronization error can be represented by the friction force. Because the blanket sheet is composed of PDMS (Poly-dimethylsilxane), the stick state between the contact surfaces maintained in a large range of synchronization error due to the easily deformable property of PDMS. In the stick stage, the relative displacement error caused by the synchronization error is linearly correlated to the friction force because the contact surface can be modeled as two surfaces connected by sprinting elements as shown in Fig. 3, It means that the friction force can represent the synchronization error and the 6-DOF dynamometer of Kistler Corp. (9256C2) is used to sense the force in contact interface. The correlation between the friction force and the synchronization error is shown in Fig. 4 and the in-line measurement results of the synchronization velocity error during the off step is presented in Fig. 5.[2)] Based on the test results, the model of synchronization error is developed and the effect of synchronization error on printing performance is estimated. Finally, the way to minimize the synchronization error is presented.

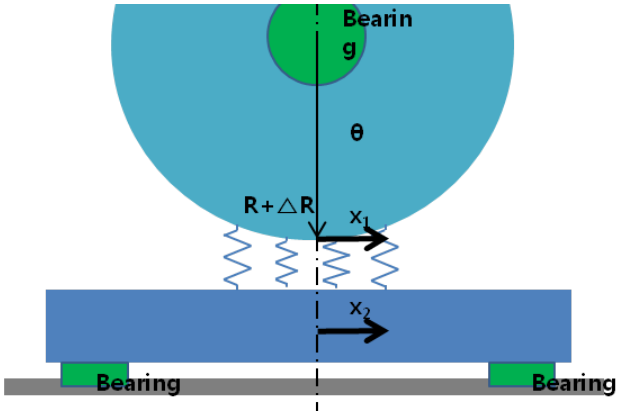

Fig. 3 Model of contact surfaces under the stick condition

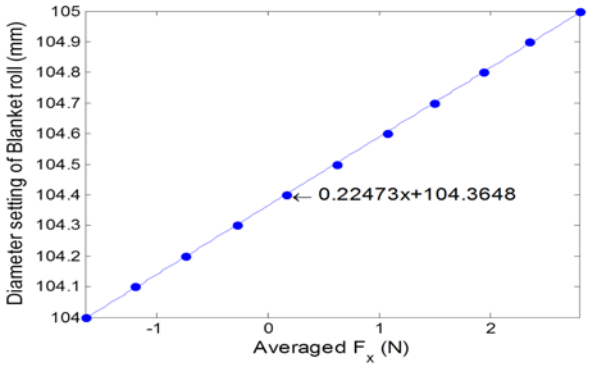

Fig. 4 Correlation result between the measured friction force and the synchronization error[2)]

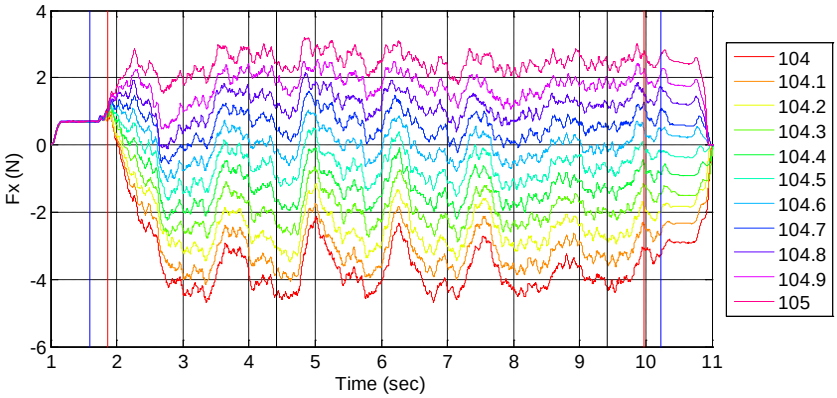

Fig. 5 In-line measurement of the velocity synchronization error between contact surfaces in the nip[2)]

Acknowledgement

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Reference

1) Bartzsch, M., Fuegmann, U., Fischer, T., Hahn, U., Kempa, H., and et al., “All-printed Electronics and Its Applications: A Status Report,” Proc. of NIP & Digital Fabrication Conference, pp. 13-16, 2006.

2) Kang, D. W., Lee, E. S., Kim, H. C., Choi, Y. M., Lee, S. H., and et al., “Investigation on Synchronization of the Offset Printing Process for Fine Patterning and Precision Overlay,” Journal of Appl. Phys., 115, pp. 234980, 2014