LABORATORY OF INJECTION MOLDING
AT FIRST TECH, KAOSHIUNG CITY, TAIWAN.

FACULTY: DIST. PROF. MING-SHYAN HUANG
Dept. of Mechanical and Automation Eng.,
National Kaohsiung First Univ. of Sci. & Tech.
Email: mshuang@nkfust.edu.tw

ASSOCIATE PROF. SHIH-CHIH NIAN
Dept. of Power Mechanical Eng.,
National Taitung Junior College

DR. TSUNG-YEN LIN
RD Manager, FCS Groups
RESEARCH FOCUS

Injection Molding
- Rapid mold surface heating – Induction heating
- Process monitoring and control
- Microinjection molding (microgear; light-guided plate)
- In-mold labeling
- eGAIM
- Robust parameters design
- Metal injection molding

Mold Design and Analysis
- Sprue-runner-gate design
- Cooling channel design

Injection Molding Machine
- VPT switchover control
- Screw design
- Clamping-unit optimal design
- System dynamics & control

Hot Embossing
**EQUIPMENTS**

- **Injection Molding Lab.**
  Injection molding machines×5 (5, 30, 50, 100, 110 Tons); Induction heating devices×3 (25, 45×2 KVA); Injection molds×10; Oven; Kistler AQCS; Futaba Mold Marshalling System; ThermoVision; Moldex3D; ScrewPlus; CenterMold, Amold; Paulson Training Program; Matlab; Femlab; Pro/E; Solidworks; COMSOL-Multiphysics.

- **Precision Measurement Teaching Lab.**
  OM; CMM; Profile Projector; Surface Roughness Tester; Laser Interferometer, etc.

- **Precision Injection Molding (PIM) Lab.**
  Sponsored by FCS Group.
FUNDING & OUTPUT

• Accumulated Research Funding
  58M NTD sponsored by MST, MOE, MOEA, ITRI, FCS, OR, WST, NKFUST, PMC, MIRDC, EMD, UEO, FW, EPIC, MILDEX, LM, etc.

• Publications (please see appendix)
  43 Journal articles / 102 Conf. papers / 72 Tech. reports / 4 Books / 17 Patents
AWARDS

• Distinguished Professor, NKFUST, 2015~2017
• 2015 Distinguished Mechanical Engineer Award, CSME-Kaohsiung Division
• 2013 Outstanding Research Award, NKFUST
• 2012, 2014 Best Paper Award, TMDIA
• 2012 Outstanding Faculty on Engineering Contributions Award, NKFUST
• 2011~2015 Distinctive Outstanding Research Faculty Awards, MOE
• 2014 Distinctive Outstanding Teaching Faculty Awards, MOE
• 2011, 2013, 2014 Taiwan Machinery Industry Industry-Academia Collaboration Contributions Award, TAMI
• 2010~2015 Distinctive Outstanding Faculty Awards, MST
AWARDS

• 2011, 2010 Excellent Research Awards, NKFUST
• 2010~2015 Who's Who in the World
• 2010 Best Paper Award, MOE
• 2009 Excellent Industry-Academia Collaboration Award, MOE
• 2008 Outstanding Teaching Award, NKFUST
• 2012, 2002 Excellent Patent Award, NKFUST
RECENT PROJECTS

- Intelligent control of plasticization process for injection molding machines: Phase 1
- Clamping force setting method for injection-molding machines
- Metering control for injection molding machines
- Influence of magnetic shielding materials on magnetic field distribution
- Adaptive online quality control for injection-molding by monitoring and controlling tie bar elongation
- Optical design and precision injection molding of Fresnel lens for LED flash lens
- Survey and analysis of energy-saving and induction heating technologies in molding industry
- Induction coil design to enhance heating performance on a curve-shaped mold surface using magnetic shielding materials
- Servo-pump motion control for an intelligent clamping system
- Precise injection molding of headlight lampshades
- Rapid mold surface induction heating for large-area injection molds
- MOEA national contest of advanced industrial equipment
Key parameters and optimal design of a single-layered induction coil for external rapid mold surface heating

- To analyze the effects of coil geometry/position; thickness of a heated target on the heating rate and temperature uniformity of induction heating on a mold surface by using a single-layered coil.
- A thicker workpiece slows the heating process and generates rapid heat dissipation after induction heating.
- The position of the induction coil exerts the most notable effect on heating uniformity.
Experimental rapid surface heating by induction for injection molding of large LCD TV frames

• Simulation and experimental heating a male mold plate of a 42-inch LCD TV frame using a single-layered induction coil was conducted to confirm the heating rate and uniformity.

• A single-layered coil with currents that flow in one direction performed induction heating of the LCD TV frame mold surface in practical injection molding provided a high heating rate of 4.5°C/s with favorable temperature uniformity (std: 4.0°C).
Non-planar induction coil design for rapid mold surface heating with magnetic shielding materials

- Target: Female mold surface of car components
- Dimension: $1,400 \times 400 \times 200$ mm
- Heated area: $1,550$ cm$^2$
- Problem: Uneven temperature
- Solution: Designing induction coil with ferrite materials to enhance heating uniformity.
A novel inductive hot embossing process for enhancing micromolding efficiency

• The shortest production cycle could be obtained within 48 in seconds, with an increase of processing temperature from room temperature to 200°C, and then cooled.

• For a big angle of v-grooves, forming pressure can slightly enhance the replication rate about 1%.

• The average replication rate could reach 97.5% when the forming temperature at 210°C.
Warpage control of thin-walled injection molding using local mold temperatures

- This work describes local mold temperature settings for a cooling system that can prevent severe warpage in an asymmetric plastic cover for handheld communication devices.
- The neutral axis theory is introduced to analyze the temperature distribution in the cross section of a part, and then predict the warping trend.
Improvement of injection molded parts appearance using external gas-assisted injection molding (eGAIM)

- The work presents the causes of ghost marks through experimental study of injection molding a tensile-testing-sample and improves them with eGAIM.
- A setting of high mold/melt temperatures as well as high injection speed/pressure enables to reduce the defect.
- Employing eGAIM has a significant effect on reducing ghost marks.
Warpage Control of Headlight Lampshades Fabricated Using External Gas-Assisted Injection Molding (eGAIM)

• Optimizing the gate location facilitates improving the flow balance and reducing the filling pressure, leading to a reduction in part deformation.

• An optimal layout of cooling channels combined with two-stage holding conditions contributed to a superior cooling effect and low volumetric shrinkage.

• Parts fabricated using eGAIM exhibited less volumetric shrinkage than did parts fabricated using conventional injection molding.
Effect of multi-layered induction coils on efficiency and uniformity of surface heating

Ming-Shyan Huang*, Yao-Lin Huang

Department of Mechanical and Automation Engineering, National Kaohsiung First University of Science and Technology, 2 Jhuoyue Road, Nanzih, Kaohsiung City 811, Taiwan, ROC

ARTICLE INFO

Article history:
Received 10 February 2009
Received in revised form 23 December 2009
Accepted 23 December 2009
Available online 12 February 2010

ABSTRACT

This article explores the effect of the design of the multi-layered coil on the efficiency and uniformity of high-frequency electromagnetic induction surface heating. This work aims to improve the non-uniform temperature distribution of the cross and depth sections of a heated target that is produced by the approximate and skin effects, which often occur in induction heating using a conventional single-layered coil. The goal is to heat rapidly and uniformly the surface of a target. An injection mold plate is used as the target of induction heating; this investigation first utilizes multiple physical coupling analyses in ANSYS software to predict the temperature profile in the various layers of a coil. The Taguchi method and principal component analysis (PCA) are then adopted to determine the best combination of process parameters with a two-layered induction coil. The effects of the multi-layered induction coils on the heating history are further examined, and are compared with those of the single-layered coil in terms of the duration of heating required to yield a surface temperature of over 100 °C and the largest heating area at uniform temperature. The experimental results show that the multi-layered coil heats to a uniform temperature more efficiently than the conventional single-layered coil, and the temperature varies within 5 °C even upon heating to 190 °C.

© 2010 Elsevier Ltd. All rights reserved.
Experimental Rapid Surface Heating by Induction for Micro-Injection Molding of Light-Guided Plates

Ming-Shyan Huang, Ning-Sheng Tai

Department of Mechanical and Automation Engineering, National Kaohsiung First University of Science and Technology, Taiwan, Republic of China

Received 10 May 2008; accepted 5 January 2009
DOI 10.1002/app.30053
Published online 8 April 2009 in Wiley InterScience (www.interscience.wiley.com).

ABSTRACT: This work experimentally investigates the use of induction-heating to heat mold surfaces rapidly, and thus enhance the replication effect of the microstructure of light-guided plates (LGP) in the injection molding process. This investigation employs a 2-inch LGP injection mold as the experimental carrier, and compares the replication effect on the microstructure of induction heating with that of conventional oil-heating. Temperature increases on the mold plate are examined using a thermal video system. The experimental results show that (1) the flat induction coil design promotes rapid surface heating. (2) Induction-heating the mold surface to 110°C improves the replication rate of the height of the microstructure by up to 95%. (3) The LGP produced by induction heating has no significant residual stress. © 2009 Wiley Periodicals, Inc. J Appl Polym Sci 113: 1345–1354, 2009

Key words: induction heating; injection molding; light-guided plate; microstructure; rapid surface heating
Effect of backbone polymer on properties of 316L stainless steel MIM compact

Ming-Shyan Huang, Hung-Chuan Hsu

Department of Mechanical and Automation Engineering and Graduate Institute of Industrial Design, National Kaohsiung First University of Science and Technology, 2 Jhuoyue Road, Nanzih District, Kaohsiung City 811, Taiwan, ROC

ARTICLE INFO

<table>
<thead>
<tr>
<th>Specimen 1</th>
<th>Specimen 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feedstock A</td>
<td></td>
</tr>
<tr>
<td>Feedstock B</td>
<td></td>
</tr>
<tr>
<td>Feedstock C</td>
<td></td>
</tr>
</tbody>
</table>

ABSTRACT

This study compares the effects of three backbone polymers, LDPE, HDPE and LDPE/HDPE, on the dimensions and mechanical properties of 316L stainless steel MIM compact. MIM parts of optimal quality can be produced using properly formulated binders. A spiral flow test is performed firstly to elucidate the flow behaviors of MIM feedstocks. Secondly, the injection molding of tensile bars is tested to examine the dimensional stability and the mechanical strength of sintered parts against variation in the binder formula. Among the three backbone polymers considered herein, HDPE performs best in terms of both the stability of flow and the MIM compact quality; LDPE performs the worst. HDPE has significantly better length, width, density, and hardness by up to 24%, 27%, 30%, and 64%, respectively. In summary, this work has demonstrated that a backbone polymer strongly affects the dimensions and the mechanical properties of the sintered part. The proper selection of a backbone polymer, such as HDPE, is required to increase the dimensional accuracy and quality of 316L sintered parts.

© 2009 Elsevier B.V. All rights reserved.
Simulation of a regression-model and PCA based searching method developed for setting the robust injection molding parameters of multi-quality characteristics

M.-S. Huang*, T.-Y. Lin

Department of Mechanical and Automation Engineering, National Kaohsiung First University of Science and Technology, 2 Jhuoyue Road, Nanzih District, Kaohsiung City 811, Taiwan, ROC

ABSTRACT

This article proposes an advanced searching method for setting the robust process parameters for injection molding based on the principal component analysis (PCA) and a regression model-based searching method. This method could effectively reduce the influence of environmental noise on molded parts’ multi-quality characteristics in the injection molding process. Firstly, the PCA is utilized to construct a composite quality indicator to represent the quality loss function of multi-quality characteristics. The design of experiment and ANOVA methods are then used to choose the major parameters, which affect parts’ quality and are called as adjustment factors. Secondly, a two-level statistically designed experiment with the least squared error method was used to generate a regression model between part quality and adjustment factors. Based on this mathematical model, the steepest decent method is used to search for the optimal process parameters. To verify the performance, computer simulations and experiment of the light-guided plate molding were investigated in this work. By comparing the robust qualities using Taguchi method and our proposed method, it is found that our proposed method yields a better uniform production quality.
Cavity pressure based grey prediction of the filling-to-packing switchover point for injection molding

Ming-Shyan Huang*

Department of Mechanical and Automation Engineering, National Kaohsiung First University of Science and Technology,
2 Juoyue Road, Nantsu, Kaohsiung, Taiwan, ROC.

Received 14 September 2004; received in revised form 15 August 2005; accepted 27 October 2006

Abstract

Filling-to-packing switchover control during injection molding plays a crucial role in ensuring the quality of the molded parts prior to production. Although this topic has been studied for years, traditional methods of filling-to-packing switchover control, such as using screw cushioning or checking injection time without indicating the actual behaviors of melt plastics being filled into the cavity, are still those mostly used in practice. The results of switchover control, therefore, are often times inaccurate while the variation in the quality of produced parts is not negligible. This study thus presents a novel method by which quick and accurate decisions concerning the ideal switchover time can be made. It has adopted a simple grey model, GM(1,1), to predict instantaneously the volumetric-filling point when monitoring the cavity pressure profile in each molding. Recently found to be a good indicator of product quality, cavity pressure profile is applied here to obtain more precise switchover control. After the experimental verifications is conducted, the results reveal that the innovative switchover method yields a more uniform product weight than any traditional methods.

© 2006 Elsevier B.V. All rights reserved.

Keywords: Injection molding; Cavity pressure; Filling-to-packing switchover; Grey predictor


Thanks for attention.