The forming of microchannels on metal foils by micro rolling technology

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Abstract

Statement of the Problem: With the increasing demand of industrial field, microchannels has attracted much attention owing to the reduction in the energy loss during heat transfer and lubrication processes. In comparison with smooth surface, microchannels located on the metal foils work as tanks for lubricants and reduce lubricant leakage during lubrication. During past decades, microchannels have been commonly used in the aerospace engineering, medical science and micro electro-mechanical systems owing to the large heat transfer surface area, excellent heat transfer capacity, compact structure, and controlled pressure drop. In recent years, a number of innovative methods were proposed to manufacture microchannels on the metal foils, including micro electrical discharge machining, lithography galvanic moulding, electrochemical micro-machining and laser processing. Compared with the methods above, micro rolling is a well-established forming process that turns the flat metal surface into the desired microstructure shape. As a simpler and economic forming method, the pre-textured rolls were applied and caused plastic deformation on the surface of metal foils during micro rolling, promoting the formation of microchannels on the metal foils. This study aims to introduce the forming of microchannels on metal foils by micro rolling technology and enhance the forming accuracy of microchannels through optimization of rolling processes. The forming mechanism of the proposed method was discussed. In order to quantitively describe the forming quality of the formed microchannels, a series of quality evaluation methods were proposed to assess the forming quality of microchannels, and the effects of material properties and forming parameters on the forming quality of microchannels were analyzed. This work provides an innovative rolling method to manufacture high-quality microchannels for industrial application and promotes the development of microforming technology in the field of medical science.

Conclusion & Significance: Micro rolling is an efficient method to manufacture high-quality microchannels on the metal foils. Through micor rolling processes, rapid production of the high-quality microchannels can be achieved, and the formed products can be utilized in a variety of fields such as medical science, aerospace engineering and micro-electro mechaincal systems. The micro rolling methods can also combined with other forming methods to manufacture more complexed microstructures. Through optimization of rolling equipment and processes, improved quality and forming efficiency of microchannels can be obtained, satisfying the demand from a variety of fields.

Image

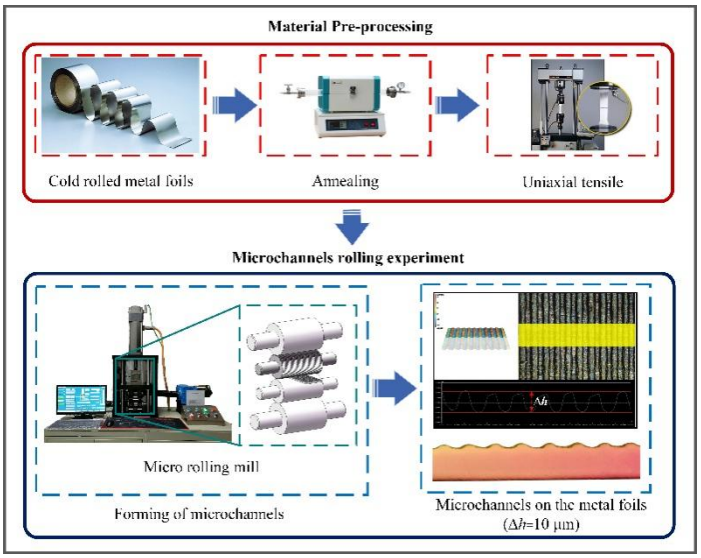

Figure 1. The diagram of the forming of microchannels on the metal foils by micro rolling processes

Recent Publications:

1. Zhao H, Ma X, Wang Z, Jiang Z, Zhou CL, Zhao J (2024) Surface roughness evolution and heterogeneous plastic deformation of austenitic stainless steel during micro deep drawing: Modeling and experiment. International Journal of Plasticity 176: 103964.
2. Zhao J, Zhang K, Ma X, Zhang J (2024) Study on the formability of copper foils during multi-step micro deep drawing. Journal of Materials Research and Technology 28: 2187-2198.
3. Wang C, Ma X, Ma L, Jiang Z, Hasan M, Islam M, Kasi A, Zhao J (2023) A study on the microstructural evolution of copper/aluminum composite strips fabricated by micro flexible rolling. Materials Characterization 205: 113315.
4. Wang C, Ma L, Ma X, Wang T, Jiang Z, Hasan M, Zhao J (2023) Effect of annealing temperature on microstructure and tensile properties of copper/aluminum composite thin strip. Transactions of Nonferrous Metals Society of China 33: 701−713.
5. Zhao J, Wang P, Ma L, Liu Z, Jiang Z, Dobrzanski LA, Lee CS, Ma X (2023) A study on the forming of microchannels by micro rolling of copper foils. Materials Characterization 200: 112900.

Photograph

Biography

Professor Jingwei Zhao is the Vice Dean of the College of Mechanical and Vehicle Engineering, Taiyuan University of Technology, China. His main research interests include microforming of metallic materials, advanced rolling and forming technology, and tribology in materials manufacturing. He has been awarded a number of competitive research projects funded by National Natural Science Foundation of China, Australian Research Council and large-scale manufacturing enterprises. He has published 4 scholarly books, 2 book chapters and over 150 research articles, which have had an impact in the field of materials processing and manufacturing, and have been acknowledged by international academic communities. He has served as an Editor or Editorial Board Member of 6 international journals and a committee member of over 20 major international conferences, and is serving as a referee for over 40 international journals. He has established solid academic contacts and collaborations with overseas universities with strong academic reputation in Australia, South Korea, Japan and Poland..

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