用於精密製造的曲率自適應多射流自由曲面拋光系統

Curvature-adaptive Multi-jet Freeform Polishing System for Precision Manufacturing

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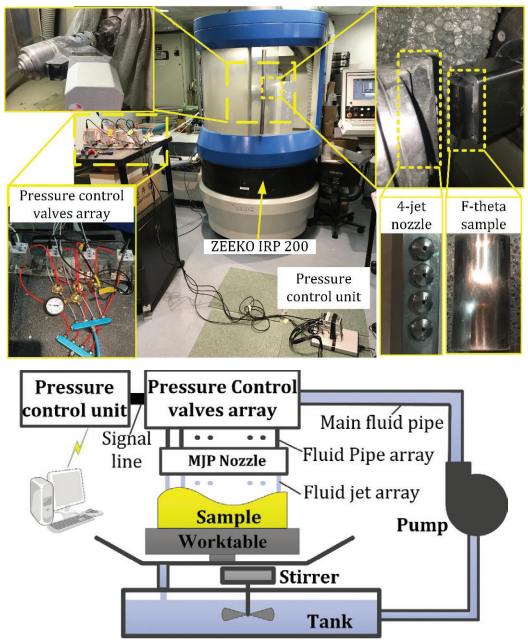
能夠克服表面曲率變化調整個別射流水壓的高效多射流拋光技術

High efficiency multi-jet polishing of freeform surfaces by controlling the fluid pressure of each jet according to surface curvatures

拋光自由曲面是工程上的一項挑戰，因為自由曲率效應往往會造成極大的殘餘誤差。廠商可利用本技術能自訂調整磨料水的射流陣列，並按曲率差異即時調控每束射流的壓力，以補償殘餘誤差。與傳統單射流拋光方法相比，新技術大大提高了自由曲面的拋光成效和精確度。團隊已利用此技術開發可移植式設備；只要把設備安裝到拋光機、機器臂和3D列印機等各類機器上，即可進行快速而精密的自由曲面拋光工序。



曲率自適應多射流自由曲面拋光系統的原型裝置
Prototype of Curvature-adaptive Multi-jet Freeform Polishing System (CAMJP)

	Curvature-adaptive multi-jet polishing	Traditional single fluid jet polishing	Traditional mechanical polishing	Manual polishing
Polishing accuracy	High	High	Medium-high	Low
Polishing efficiency	High	Low	Medium-high	Medium
Polishing stability	High	High	Medium-high	Low
Adaptability to surface curvature variation	Good	Good	Poor	Poor
Scalability	Good	Poor	Good	Good
Temperature rise of workpiece	No	No	Yes	Yes

CAMJP與其他拋光技術的比較
Comparison of CAMJP with other existing polishing methods

Polishing freeform surfaces is a great engineering challenge, as the curvature effect always results in considerable residual errors. Our novel technology enables jet array customization and real-time control and adjustment of the fluid pressure of each jet according to surface curvatures, in order to compensate residual errors induced by the curvature effect. Compared to conventional single jet polishing, it tremendously enhances the efficiency and accuracy of freeform surface polishing. It has been developed into a portable apparatus which can be integrated into various types of machines such as polishing machines, robotic arms and 3D printing machines.

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專利申請編號: 201710036690X, 2017100138091, 2018103008855 (中國)

特色與優點

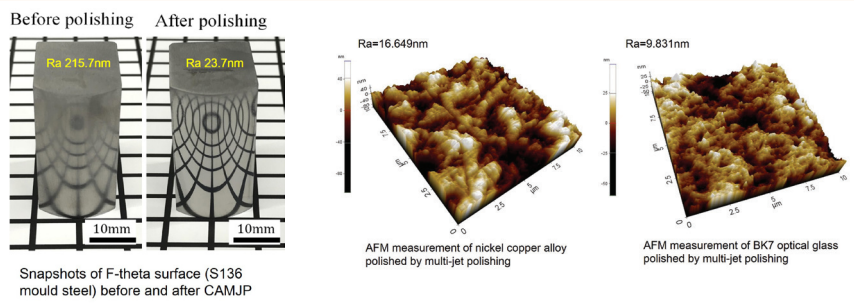
- 與傳統的單射流拋光相比，大大提高了拋光效率，同時保持了成品的質量
- 根據自由曲面的曲率，獨立地控制各射流的流體壓力，以去除曲面效應所帶來的殘餘誤差
- 可移植式設備，可安裝於各類機器上

應　用

- 自由曲面工件的後期處理拋光工序，適用於各個範疇及各類材料，包括生物醫學（如整形外科植入物）、光學（如自由曲面鏡片和模具）及航空航天（如渦輪葉片）等
- 3D 打印複雜工件的後期處理拋光工序

獎　項

- 第十四屆中日超精密加工技術國際會議 - 最佳論文獎 (2018年9月)
- 第47屆瑞士日內瓦國際發明展 - 銀獎 (2019年4月)
- 布加勒斯特理工大學優異獎 (2019年4月)
- 羅馬尼亞創新科技協會優異獎 (2019年4月)



用CAMJP拋光後的前後對比圖
Comparison the polishing result after CAMJP polishing

Patent Application No. and Country: 201710036690X, 2017100138091, 2018103008855 (China)

Special Features and Advantages

- Greatly enhances the polishing efficiency as compared to traditional single jet polishing, while maintaining high surface quality
- Controls the fluid pressure of each jet for material removal independently according to the curvatures of the freeform surface
- Portable apparatus that can be integrated with different machines

Applications

- Post-process finishing of freeform surfaces made of different materials in various fields such as biomedical (e.g. orthopedic implants), optics (e.g. freeform lenses and molds), and aerospace (e.g. turbine blades)
- Post-process finishing of 3D-printed complex components

Awards

- Best Paper Award - The 14th China-Japan International Conference on Ultra-Precision Machining Process (Sept 2018)
- Silver Medal – 47th International Exhibition of Inventions of Geneva, Switzerland (Apr 2019)
- Special Merit Award from University Politehnica of Bucharest, Romania (Apr 2019)
- Special Merit Award from Romanian Association for Nonconventional Technologies, Romania (Apr 2019)

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