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微纳技术与精密机械

超声处理对UV-LIGA工艺中SU-8胶溶胀的影响

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摘要： 首次将超声处理引入UV-LIGA工艺中,研究了超声处理对SU-8胶模溶胀的影响,并探讨了其影响机理,从而获得了减小胶模溶胀及提高电铸微器件尺寸精度的方法。试验研究了超声处理对显影过程及电铸过程中SU-8胶模溶胀的影响,分析了不同超声时间下SU-8胶表面亲水性的变化趋势,并计算了不同超声时间下胶模的溶胀去除率。讨论了超声处理对不同结构微器件尺寸精度的影响。试验结果表明:SU-8胶模在显影过程中的溶胀不明显,并且超声处理对显影过程中胶模的溶胀影响很小,其主要影响SU-8胶模在电铸过程中的溶胀。随着超声时间的增加,胶模溶胀及其表面亲水性均呈现先减小后增大的趋势。当超声时间为10 min时,胶模溶胀最小,其溶胀去除率α值可高达70%,并且超声处理后电铸微器件的尺寸误差与结构尺寸无关。根据超声波的机械断键作用与聚合物吸水机理,从亲水性和内应力两个方面,探究了SU-8胶模溶胀随超声时间的增加而变化的原因。文中提出的减小SU-8胶溶胀的方法不依赖于工艺参数也不会增加掩模图形设计的复杂性,是一种实用的减小SU-8胶溶胀的新方法。

关键词： 超声处理 SU-8光刻胶 溶胀 电铸 UV-LIGA

Effect of ultrasonic treatment on SU-8 swelling in UV-LIGA technology

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Abstract: Ultrasonic treatment was originally introduced into UV-LIGA technology in this paper. The effect of ultrasonic treatment on SU-8 swelling was researched, and ultrasonic mechanism of SU-8 swelling was explored. Then, a novel method to reduce SU-8 swelling and improve the dimensional precision of an electroformed microstructure was obtained. In experiments, the effect of ultrasonic treatment on the SU-8 swelling during the development and electroforming process was respectively studied, the surface hydrophilicity of SU-8 photoresist in different ultrasonic time was analyzed, and the SU-8 swelling removal ratio in different ultrasonic time was calculated. Furthermore, the effect of ultrasonic treatment on the dimensional precisions of different micro devices was discussed. The experimental results indicate that the SU-8 mould swelling in development process is not obvious, and the ultrasonic treatment has a little effect on the SU-8 mould swelling during development process. The effect of ultrasonic treatment on the SU-8 mould swelling mainly occurs in the electroforming process, and the SU-8 swelling and its surface hydrophilicity both decrease first and increase afterwards with increasing the ultrasonic time. By 10 min ultrasonic treatment, the SU-8 swelling removal ratio is up to 70%, and the dimensional error of electroformed microstructure is independent on the structure of SU-8 mould. Moreover, the reason that SU-8 swelling behavior varies with increasing ultrasonic time was explained based on the ultrasonic mechanical scission of polymer chain and water absorbing mechanism. In conclusion, the presented method to reduce the swelling of SU-8 resist mould does not depend on the process parameters and not increase the complexities of mask layouts, and is a practical method.

Keywords: ultrasonic treatment SU-8 photoresist swelling electroforming UV-LIGA

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