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Determination of nano-roughness for micro-objects by measuring the van der Waals force

Bratina, B.[a,*], **Šafarič, J.**[a], **Uran, S.**[a], **Šafarič, R.**[a]

[a]Faculty of Electrical Engineering and Computer Science, University of Maribor, Maribor, Slovenia

ABSTRACT

3D printing or assembly techniques in the micro/nano-world enable production of micro-parts for building small machines or structures for biomedicine applications, such as cultivation of living cells in the field of Tissue Engineering. Micro-sized assembly requires automated manipulation procedures and methods for determination of suitable objects for assembly. The latter is possible by van der Waals force measurement and determination of distance at the van der Waals peak between two objects in contact. They are dependent not only on the Hamaker coefficients of the materials in contact and their geometries, but also on the nano-roughness asperities and crystal structure asperities of the contact surfaces. A method is presented for measuring van der Waals` force and determining micro-objects' (sizes between 10-100 μm) distances between materials in contact at the van der Waals peak in the presence of nano-roughness and crystal structure roughness. The proposed model was validated by experimental lab results between various materials and shapes (glass and polystyrene beads, metallic wires).

ARTICLE INFO

Keywords:
Micro-object;
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**Corresponding author:*
bozidar.bratina@um.si
(Bratina, B.)

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Izvirni znanstveni članek

Določanje nanohrapavosti mikropredmetov z merjenjem van der Waalsove sile

Bratina, B.[a,*], **Šafarič, J.**[a], **Uran, S.**[a], **Šafarič, R.**[a]

[a]Faculty of Electrical Engineering and Computer Science, University of Maribor, Maribor, Slovenia

POVZETEK

Tehnike 3D tiskanja ali montaže v mikro/nano svetu omogočajo izdelavo mikropredmetov za gradnjo majhnih strojev ali struktur za potrebe biomedicine, kot je gojenje živih celic na področju tkivnega inženiringa. Sestavljanje na nivoju mikrovelikosti zahteva avtomatizirane postopke manipulacije in metode za določanje primernih predmetov za sestavljanje. Slednje je mogoče z meritvijo Van der Waalsove sile in določitvijo razdalje med dvema kontaktnima objektoma pri največji Van der Waalsovi sili. Odvisni niso le od Hamakerjevih koeficientov materialov v stiku in njihove geometrije, temveč tudi od nanohrapavosti in kristalne strukture kontaktnih površin. Predstavljena je metoda za merjenje Van der Waalsove sile in določanje razdalj med mikropredmeti (velikosti 10-100 μm) med materiali, ki so v stiku pri največji Van der Waalsovi sili, ob prisotnosti nanohrapavosti in hrapavosti kristalne strukture. Predlagani model je bil potrjen z eksperimentalnimi laboratorijskimi rezultati na različnih materialih in oblikah (steklene in polistirenske kroglice, kovinske žice).

PODATKI O ČLANKU

Ključne besede:
Mikropredmet;
Hrapavost površine;
Nanohrapavost;
Van der Waals sila;
Razdalja pri največji van der Waals sili

**Kontaktna oseba:*
bozidar.bratina@um.si
(Bratina, B.)

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