nano@illinois

Research Experiences for Teachers (RET)



Teacher Guide:

1. Description of module: An Introduction to Self-Rolled-Up Membranes.
2. Learning objectives: Students will be able to:

a. Observe examples of S-RUM’s.

b. Learn what makes self-rollup possible.

c. Experiment with self-rollup in a simple system.

1. See how S-RUM’s might be used in the future.
2. Alignment with Next Generation Science Standards:

**MS-PS2-2   Motion and Stability: Forces and Interactions**

1. Target grade level(s): K-12 or the general public
2. Target subject(s): physical science and engineering
3. Prerequisite knowledge/skills: none
4. Background: none
5. Duration: 40 minutes
6. Preparation time: 15 minutes on the day of activity
7. Preparation notes for materials and chemicals: Depends on materials chosen by instructors and students. If common materials like adhesive tape and paper ribbon are chosen, there is no special preparation required.
8. Safety: Depends on materials chosen by instructors and students. If common materials like adhesive tape and paper ribbon are chosen, there are no hazards.
9. Waste disposal: Depends on materials chosen by instructors and students. If common materials like adhesive tape and paper ribbon are chosen, there are no special waste considerations.
10. Materials/supplies/equipment needed with example source listed/pricing/CAS # and contact  information: Depends on materials chosen by instructors and students. If common materials like adhesive tape and paper ribbon are chosen, they may be purchased at many local stores.
11. Procedure/activity:
12. Recognize self-rollup and curling behavior in thin materials, films, and membranes. This brief activity might involve curling ribbon used for holiday package decoration. When one side of the ribbon is drawn across a hard edge (ruler, straightedge, table edge, etc.), it curls tightly. This material can become part of an open-ended exploration of factors affecting curling radius.
13. Investigate materials and experimental conditions for producing self-rollup in bilayer films. This may involve bilayers with differing mechanical or thermal properties. Good examples are the bimetallic springs found in thermostatic devices or some thermometers.
14. Experiment with strained bilayer films that curl. Students could propose tests on the systems that they have earlier brainstormed. A simple system to start with is strips of adhesive tape forming bilayers on any clean hard surface. If one of the two strips is stretched prior to being adhered, it will have a built-in strain. A difference in strain between the two layers can lead to rollup.
15. Control strain and measure curvature in bilayer films. This may vary depending on the system, but controlled strain may be introduced by pulling films (such as adhesive tape) with a constant force before they are adhered to a surface.
16. Observe applications of self-rolled-up microscale tubes. View YouTube videos.
17. PowerPoint talking points:
18. Some links to the research articles:
19. <http://cen.acs.org/articles/92/web/2014/11/Silicon-Nitride-Microtubes-Direct-Neuron.html>
20. <http://mocvd.ece.illinois.edu/publications/pubs/Nanotech_Paul_SiNtube_2013.pdf>
21. <http://mocvd.ece.illinois.edu/publications/pubs/NL_geometry_SNT_2010_finalprint.pdf>
22. <http://mocvd.ece.illinois.edu/publications/pubs/JPD_review-2008.pdf>
23. <http://www.scientificamerican.com/article/secret-of-ribbon-curling/>
24. “Financial support was provided by the National Science Foundation under grant #NSF  EEC 14-07194 RET.”
25. With thanks to Paul Froeter (research mentor), Xiuling Li (faculty mentor), and the RET staff and other RET teachers who provided support and encouragement.
26. Information about RET and Center for Nanoscale Science and Technology (provided in template)
27. Contact information for Center for Nanoscale Science and Technology (provided in template)
28. "This work, which includes teacher and student resources, is licensed under a Creative Commons Attribution- Noncommercial-Share Alike 3.0 Unported License. To view a copy of this license, visit: http://creativecommons.org/licenses/by-nc-sa/3.0/. To attribute this work, please use [as an example]: “J. Doe. Title (Date).”

Financial support was provided by the National Science Foundation under grant #NSF EEC 14-07194 RET, as part of the nano@illinois project, through the University of Illinois Center for Nanoscale Science and Technology and the Micro and Nanotechnology Lab at the University of Illinois at Urbana-Champaign.

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The *nano@illinois* Research Experience for Teachers (RET) at the University of Illinois at Urbana-Champaign (from 2014-2017) exposes a diverse set of in-service and pre-service science, technology, engineering, and mathematics (STEM) teachers and community college faculty from across the nation to cutting-edge research in nanotechnology. The RET focuses on recruiting underrepresented minority populations (focused on ethnicity, geography, disability, and veteran status) including women and will target teachers from high-need areas, including inner city, rural, low-income, and those with significant URM students. Participants conduct research over 6 weeks in world-class labs with 4 follow-up sessions during the school year.

Teacher professional development opportunities includes teacher-focused lectures, mentoring, networking, poster sessions, ethics seminars, hands-on modules, STEM education issues, career choices, and resources for implementing a nano lab and curriculum. Teachers will develop modules to be disseminated widely and present their results. High-quality follow-up sessions and evaluation will be infused.

The nano@illinois Research Experiences for Teachers (RET) is managed by the University of Illinois Center for Nanoscale Science Technology.

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