

Reporting Summary

Nature Research wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Research policies, see [Authors & Referees](#) and the [Editorial Policy Checklist](#).

Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a Confirmed

- ☐ ☒ The exact sample size (n) for each experimental group/condition, given as a discrete number and unit of measurement
- ☐ ☒ A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
- ☒ ☐ The statistical test(s) used AND whether they are one- or two-sided
Only common tests should be described solely by name; describe more complex techniques in the Methods section.
- ☒ ☐ A description of all covariates tested
- ☐ ☒ A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
- ☐ ☒ A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
- ☒ ☐ For null hypothesis testing, the test statistic (e.g. F , t , r) with confidence intervals, effect sizes, degrees of freedom and P value noted
Give P values as exact values whenever suitable.
- ☒ ☐ For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
- ☒ ☐ For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
- ☒ ☐ Estimates of effect sizes (e.g. Cohen's d , Pearson's r), indicating how they were calculated

Our web collection on [statistics for biologists](#) contains articles on many of the points above.

Software and code

Policy information about [availability of computer code](#)

Data collection TEM Imaging & Analysis (TIA) associated with TEM version 4.0

Data analysis Solidworks 2019, TEM Imaging & Analysis (TIA) associated with TEM 4.0, Origin 9.0, VESTA 3.4.5, GetReal Software 16, LAMMPS (5 June 2019)

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors/reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Research [guidelines for submitting code & software](#) for further information.

Data

Policy information about [availability of data](#)

All manuscripts must include a [data availability statement](#). This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A list of figures that have associated raw data
- A description of any restrictions on data availability

The data that support the findings of this study are available from the authors on reasonable request, see author contributions for specific data sets.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

- ☒ Life sciences ☐ Behavioural & social sciences ☐ Ecological, evolutionary & environmental sciences

Life sciences study design

All studies must disclose on these points even when the disclosure is negative.

Sample size	No sample-size calculation is needed in this study. Mantis shrimp dactyl clubs were acquired from at least three different adult individuals growing at different time, which are sufficient to investigate their structure and materials properties. There is no big differences of structures and material properties among different individuals.
Data exclusions	No data was excluded from the analyses.
Replication	All the structures and mechanical properties tested in different samples from different individuals are similar and reproducible. We have been testing samples from at least three individuals to make sure the reproducibility of the experimental findings.
Randomization	This is not relevant to our study, since we don't have different experimental groups.
Blinding	Blinding is not relevant to this study, since we don't have different experimental groups here.

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems		Methods	
n/a	Involved in the study	n/a	Involved in the study
☒	☐ Antibodies	☒	☐ ChIP-seq
☒	☐ Eukaryotic cell lines	☒	☐ Flow cytometry
☒	☐ Palaeontology	☒	☐ MRI-based neuroimaging
☐	☒ Animals and other organisms		
☒	☐ Human research participants		
☒	☐ Clinical data		

Animals and other organisms

Policy information about [studies involving animals](#); [ARRIVE guidelines](#) recommended for reporting animal research

Laboratory animals	The study did not involve laboratory animals.
Wild animals	The mantis shrimps studied in this research were purchased from a commercial source, the Tropical Reef Store in California, USA. The species of the mantis shrimp is <i>Odontodactylus scyllarus</i> . The mantis shrimps were caught in the Pacific Ocean by the store. The live mantis shrimps are transported in a seawater container and via flight. The mantis shrimps were kept alive before further studies. When extracting dactyl club samples, live mantis shrimps were first immersed in eugenol solution for anesthesia purpose. Mantis shrimps are still alive after extracting of dactyl clubs. However, they will died naturally after couple of months.
Field-collected samples	The study did not involve samples collected from field.
Ethics oversight	No ethical approval or guidance required for this study.

Note that full information on the approval of the study protocol must also be provided in the manuscript.