Corundum formation and distribution around an evolved star R Cas
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Corundum (Al₂O₃)
- one of the first condensates
- a condensation seed for major dust species (silicates, metals)

Anisotropic crystals
- anisotropic optical property
- anisotropic growth/evaporation rates

Purposes
In order to understand the dust formation & distribution in circumstellar environments, we performed
- condensation anisotropy of cor.
- calculation of IR spectra of corundum w/ various aspect ratios
- observations (chondrite/AGB star)

Corundum Condensation Experiments
Tgas [°C] | T1 [°C] | S1 | T2 | S2 | t [h]
---|---|---|---|---|---
1695 | 1590 | 5 | 1475 | 70 | 9
1605 | 1490 | 9 | 1370 | 180 | 6-18
1535 | >1435 | <5 | - | - | 240
1505 | 1380 | 15 | 1260 | 330 | 120,360

Condensates
Tgas=1695°C
- T2=6 mm, T1=5 mm, S1=5
- T2=4 mm, S2=70
- T2=3 mm, S1=9
- T2=2 mm, S2=12

Tgas=1605°C
- T2=6 mm, T1=5 mm, S1=5
- T2=4 mm, S2=70
- T2=3 mm, S1=9
- T2=2 mm, S2=12

Tgas=1505°C
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Shape effects on IR spectral peaks
Fo. ellipsoids
- Bohren & Huffman 1983
Fo. rectangles (DDA)
- Draine & Flatau 2009

Shapes can be distinguished from peak position in the 10-mm band
Edge effects are negligible
Tabular / columnar corundum can be distinguished from peak positions
The 13-um peak may be attributed to tabular/granular corundum grains

Summary of experiments
Evaporation
Condensation
cooling timescale ~10^15 yr
local-transient heating & cooling (Kozasa & Hasegawa, 1987)

Dust distribution around R Cas
R Cas: a mira variable w/ a period of 420 days
Observation: N-band long-slit spectroscopy & imaging with Subaru/COMICS
- Airmass of RCas: 1.19, Standard (beta Peg): 1.29
- 1pix = 0.165 arcsec

Asymmetric structure of dust shell in the N-band (symmetry in the Q-band)
- Corundum grains are only present at inner regions of dust shell
- Silicates are rich in outer regions of dust shell

Conclusions
- Corundum anisotropically condensed depending on supersaturation ratios
  granular or tabular grains at S<10
  columnar grains at S>70
- Difference of anisotropically crystallographic shapes can be distinguished from an IR spectrum
- Spatial distribution of the 13-micron peak is detected for the first time
  --> Possible scenario of dust formation around R Cas
  1. Corundum condensation at S<10 (not by transient cooling)
  2. Amorphous silicates condensation on corundum grains

Crystal habit of corundum in chondrite
EBSD analysis for corundum grains in Bishunpur (after SIMS analysis)

One platy corundum flattened along the c-axis was found

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