Phase-Change Films for Thermally-Tunable Ultrasensitive Infrared Absorption Spectroscopy

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\begin{figure}
\centering
\includegraphics[width=\textwidth]{graph.png}
\caption{IR absorbance of PMMA and GST.}
\end{figure}
Tunable surface colors

Colors achieved with aGST on Al

Colors diminish with crystallization

Tunable surface colors

Colors achieved with aGST on Al
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Tunable surface colors

Colors achieved with aGST on Al

Colors diminish with crystallization

Increasing GST thickness

Color scales achieved with Al, Ag, Au

Tunable surface colors

Rough and bendable substrates are OK

Color scales achieved with Al, Ag, Au

Electrothermal color change
Metal mirror is the heater

Color scales achieved with Al, Ag, Au

Tunable IR reflectance

Strong interference is extended into IR for cGST
aGST is lossless $\lambda > 1.5$ µm

Bakan et al. ACS Sensors 1: 1403 (2016)
Tunable IR reflectance/emission

Strong interference is extended into IR for cGST
aGST is lossless $\lambda > 1.5 \, \mu m$

Bakan et al. ACS Sensors 1: 1403 (2016)
Infrared absorption spectroscopy

Detecting materials by infrared absorption

Infrared absorption spectroscopy

Detecting materials by infrared absorption

Large absorbance for large $t$ or $|E|^2$

Infrared absorption spectroscopy

Large absorbance for large $t$ or $|E|^2$

Detecting materials by infrared absorption


Infrared absorption spectroscopy

Large absorbance for large $t$ or $|E|^2$

Surface Enhanced Infrared absorption spectroscopy

Adato et al. PNAS 106: 9227 (2009)
Surface Enhanced Infrared absorption spectroscopy

Adato et al. PNAS 106: 9227 (2009)
Surface Enhanced Infrared absorption spectroscopy – Limitations

Adato et al. PNAS 106: 9227 (2009)

Requires electron-beam lithography
Small area (100x100 µm²)


Field-enhancement is confined to edges

Narrow bandwidth

Strong dependence on antenna dimensions
Solution: Enhancing the field on the entire surface

Larger bandwidth and flatter spectrum with low $n_d$

Ayas et al. ACS Photonics 3: 342 (2016)
Tunable enhanced infrared absorption spectroscopy surfaces

Field enhancement redshifts with crystallization

Bakan et al. ACS Sensors 1: 1403 (2016)
Tunable enhanced infrared absorption spectroscopy surfaces

Field enhancement redshifts with crystallization and the GST film thickness

Bakan et al. ACS Sensors 1: 1403 (2016)
Conclusions

- aGST films on metals provide surface colors
  - Crystallization changes the color
- cGST films on metals show absorption in the IR
  - Absorbance = Emissivity

Funding Sources:
- TUBITAK 114E960
- FP7:People-IAPP NanoBacterPhageSERS
Conclusions

- aGST films on metals provide surface colors
  - Crystallization changes the color
- cGST films on metals show absorption in the IR
  - Absorbance = Emissivity
- aGST on metals enhances $|E|^2$ on the surface in the IR
  - Provides spectroscopy substrates for thin materials
  - Crystallization redshifts the enhancement band

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