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Media

GSvit is based on use of a regular rectangular mesh, so we use e.g. 200x200x200 rectangular volume elements - voxels on which our problem is defined. Individual voxels in the computational domain can be filled with any material and there is no limitation on this, as discussed e.g. in sections on [basic geometries](#) and [tetrahedral meshes](#).

Internally, there are two basic ways how to assign the material properties to particular voxel:

- four 3D arrays representing local permittivity, permeability, electric and magnetic conductivity are used for completely general handling of a material, e.g. having a smooth gradient in the sample. This requires to have the arrays in memory, so for large computational domains it can be memory demanding
- one 3D integer array is used for materials definition, filled by material indices, while the material parameters itself are stored in a lookup table. This is suitable for small number of materials in the computational domain, however, also more complex materials, like metals, can be handled.

We can also combine both approaches - to load the local optical properties to the four arrays, but then to place some material set by lookup table over them.

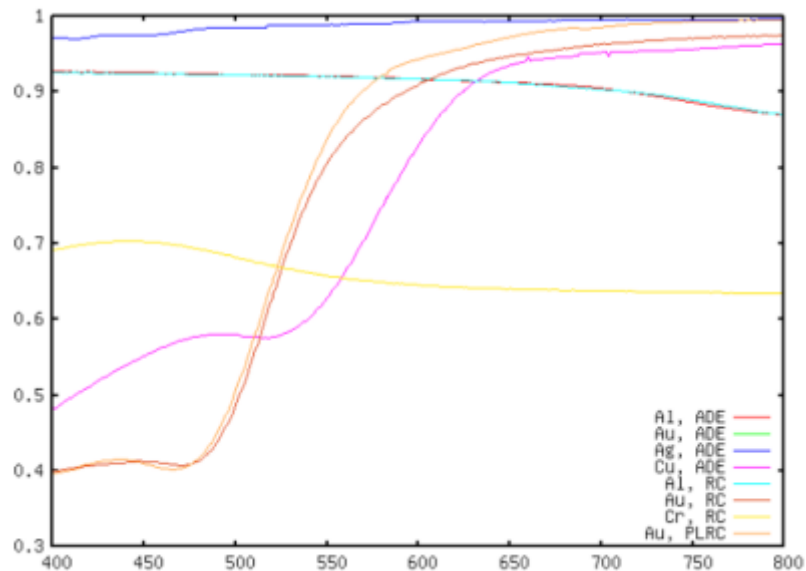
Vacuum and linear materials

These are handled using either lookup table or detailed arrays, however in both cases the material is defined by relative permittivity, permeability, electrical conductivity and magnetic conductivity, right as these appear in the Maxwell's equations. So, for vacuum this set would be (1 1 0 0).

Ideal metals

Realistic metals

There are the few different effects that we can observe when illuminating a nanoscale metallic structure. First of all, we can observe effect of spectral properties of the particular metal from which the structure is formed. Even the simplest possible quantity observed on metals in everyday life - its excellent reflectivity - is material dependent and the different appearance of different metals is its consequence. This can be handled via FDTD easily as there are many different algorithms enabling us to parametrize the spectral dependence of optical properties of metal and use them in the calculation. These algorithms also hide fact that the propagation of light through metal described only by its complex permittivity can't be handled easily via conventional grid spacing and time steps. An example of calculated metal reflectivity via FDTD for different metals and algorithms is shown in section [Media](#).



Spectral dependences of metal surface reflectivity for different materials and different numerical techniques. Note that Chromium curves are almost entirely identical (so that ADE curve is hidden behind the RC one), and also Aluminum curves are very similar. For gold, slightly different dispersive properties were used for RC and for ADE/PLRC technique, using those presented in original papers, so the curves are not expected to be identical. Also, PLRC and ADE result for gold is indistinguishable.

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