Supplemental material
A Discrete Polydisperse Porous BSDF Model based on the Micrograin Framework

Abstract

We introduce a discrete polydisperse micrograin BSDF model for the rendering of porous surface materials composed of microscopic elements of different size, shape and reflectance distributed on a bulk medium. Our approach generalizes the anisotropic monodisperse model [LRPB24]. We first reformulate it in a non-axis-aligned configuration, allowing for the later combination of different micrograin types elongated in arbitrary directions. We then extend the monodisperse model to the polydisperse case, deriving its three key components: (i) a general filling factor that controls the mix between micrograins and the bulk medium; (ii) an exact normal distribution function for surfaces composed of polydisperse micrograin distributions; and (iii) the corresponding fully-correlated shadowing and masking term. This results in an analytical single-scattering BSDF for discrete polydisperse surface materials, validated over ground truth simulations, for which we also derive a dedicated importance sampling procedure. Our model supports varying heights and anisotropy orientations of different micrograin types as input, giving additional control to simulate phenomena like retro-reflection from mixed materials, color mixture depending on lighting and observation directions, multiple directions of anisotropy, etc.

In this supplementary material, we present additional validation results of our model. (Section 1) and demonstrate further visualizations achievable with our model (Section 2).

Contents

1 Validation via simulation

This Section is an extension of Section 6 (Validation) of the paper.

Configuration of set 1, use in Figure 1 and 2

- Config. A : $r_A = 0.667$ and $\tau_{A,0} = 0.2$ (conductor aluminium (Al))
- Config. B : $r_B = 1.0$ and $\tau_{B,0} = 0.15$ (conductor gold (Au))
- Config. C : $r_C = 0.667$ and $\tau_{C,0} = 0.1$ (bluish plastic ($\eta = 1.6$, $K_d = 0.2, 0.2, 1.0$))
- Config. D : $r_D = 0.533$ and $\tau_{D,0} = 0.2$ (greenish diffuse ($K_d = 0.2, 1.0, 0.2$))
- Bulk : Absorbing

Configuration of set 2, use in Figure 3 and 4

- Config. E : $r_E = 0.5$ and $\tau_{E,0} = 0.1$ (greenish diffuse ($K_d = 0.2, 1.0, 0.2$))
- Config. F : $r_F = 1.0$ and $\tau_{F,0} = 0.2$ (conductor silver (Ag))
- Config. G : $r_G = 1.0$ and $\tau_{G,0} = 0.2$ (bluish diffuse ($K_d = 0.2, 0.2, 1.0$))
- Config. H : $r_H = 0.5$ and $\tau_{H,0} = 0.1$ (conductor gold (Au))
- Bulk : Absorbing

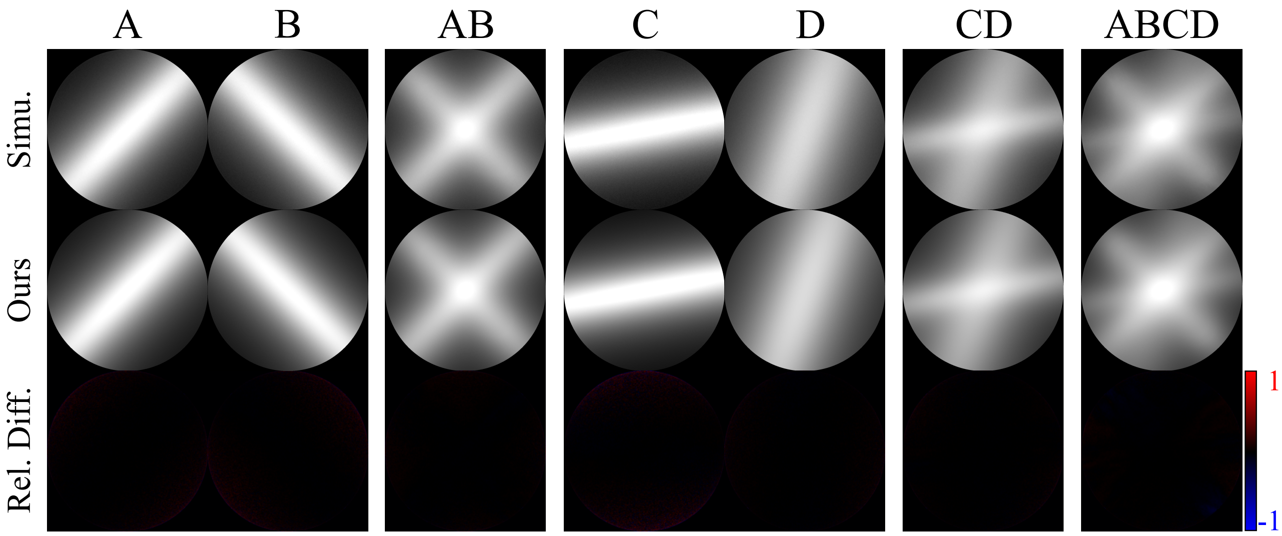


Figure 1: Validation of polydiperse micrograin NDF with a set of 4 different micrograins (A, B, C, D)

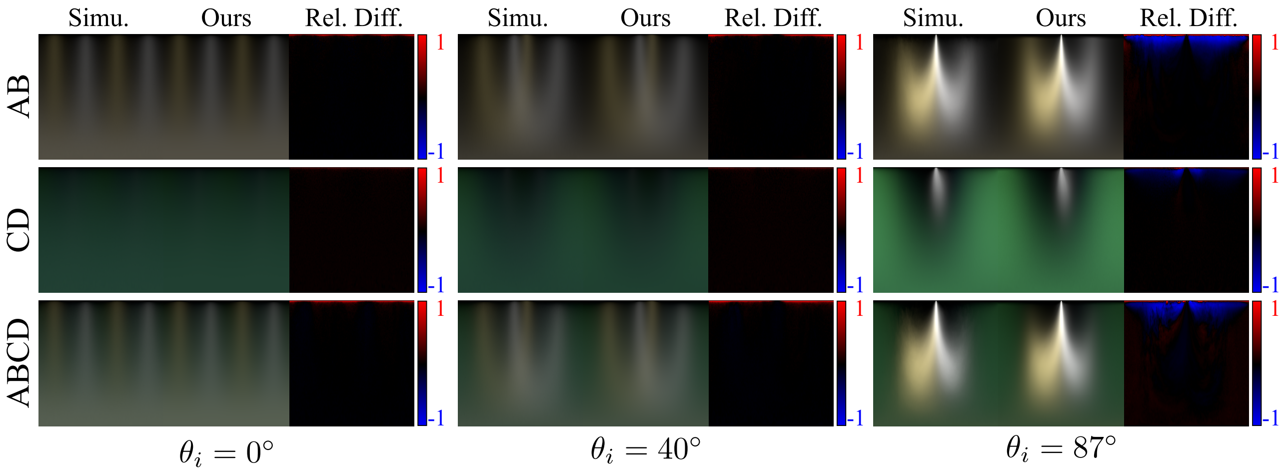


Figure 2: Validation of polydiperse micrograin BSDF with a set of 4 different micrograins (A, B, C, D)

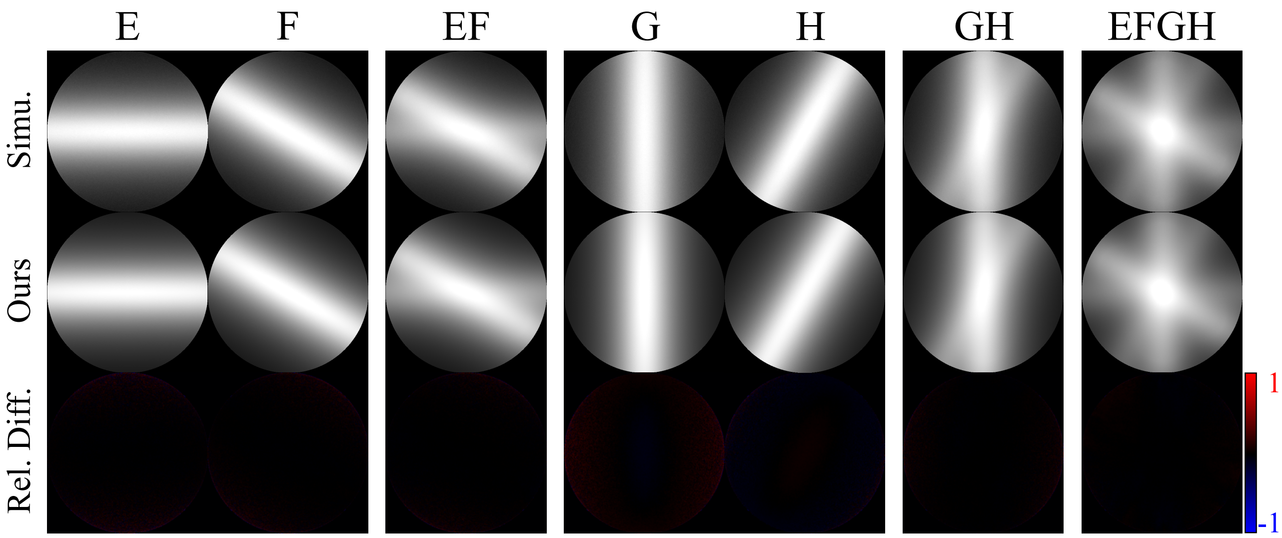


Figure 3: Validation of polydiperse micrograin NDF with a set of 4 different micrograins (E, F, G, H)

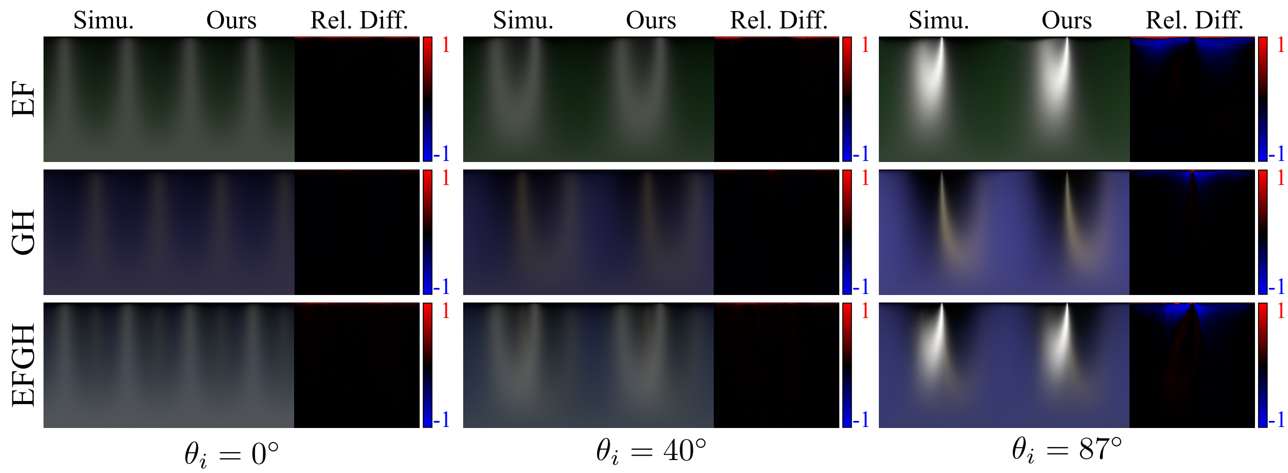


Figure 4: Validation of polydiperse micrograin BSDF with a set of 4 different micrograins (E, F, G, H)

2 More results

This Section is an extension of Section 7 (Results) of the paper. Here, we demonstrate further variations in our model parameters. First, we demonstrate the bulk surface and monodisperse cases, Figure 5. The subsequent polydisperse appearances are all based on these, with the addition of different type of micrograin : Figure 6, 7 and 8. All second micrograins use the same stretching matrix $M_2 = [\begin{smallmatrix} 10 & 50 \\ 0 & 100 \end{smallmatrix}]$.

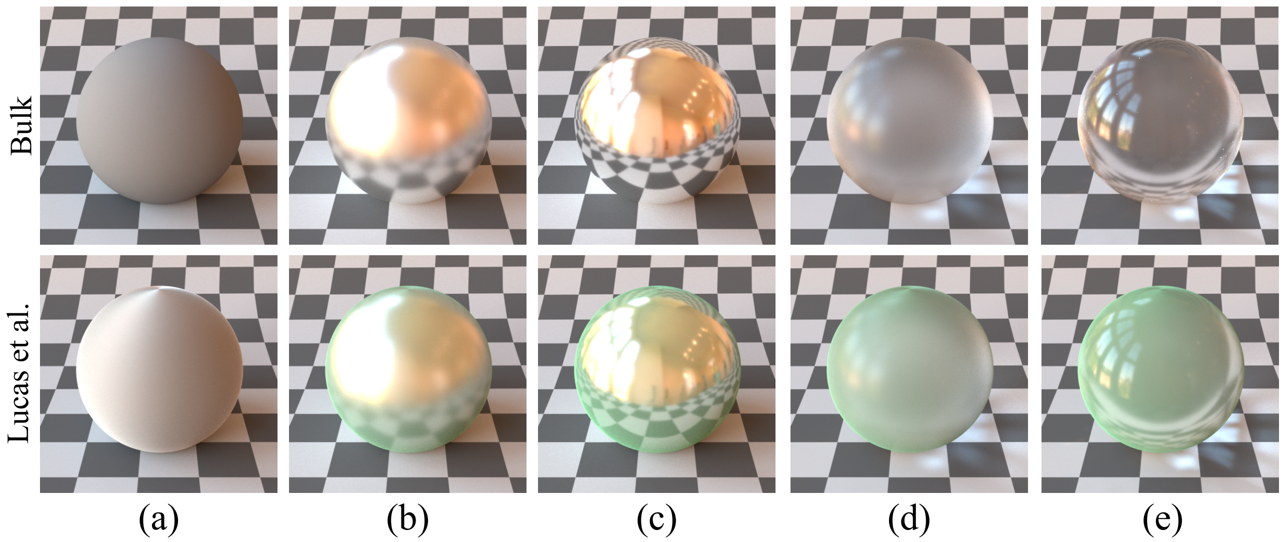


Figure 5: All first micrograin have the same configuration of shape and filling factor with $M_1 = [\begin{smallmatrix} 2 & 0 \\ 0 & 1 \end{smallmatrix}]$, $\tau_{1,0} = 0.3$. (a) A silver micrograin on a gray diffuse bulk. (b) A greenish plastic micrograin on a rough silver bulk. (c) A greenish diffuse micrograin on a smooth silver bulk. (d) A greenish plastic micrograin on a rough dielectric bulk. (e) A greenish diffuse micrograin on a smooth dielectric bulk.

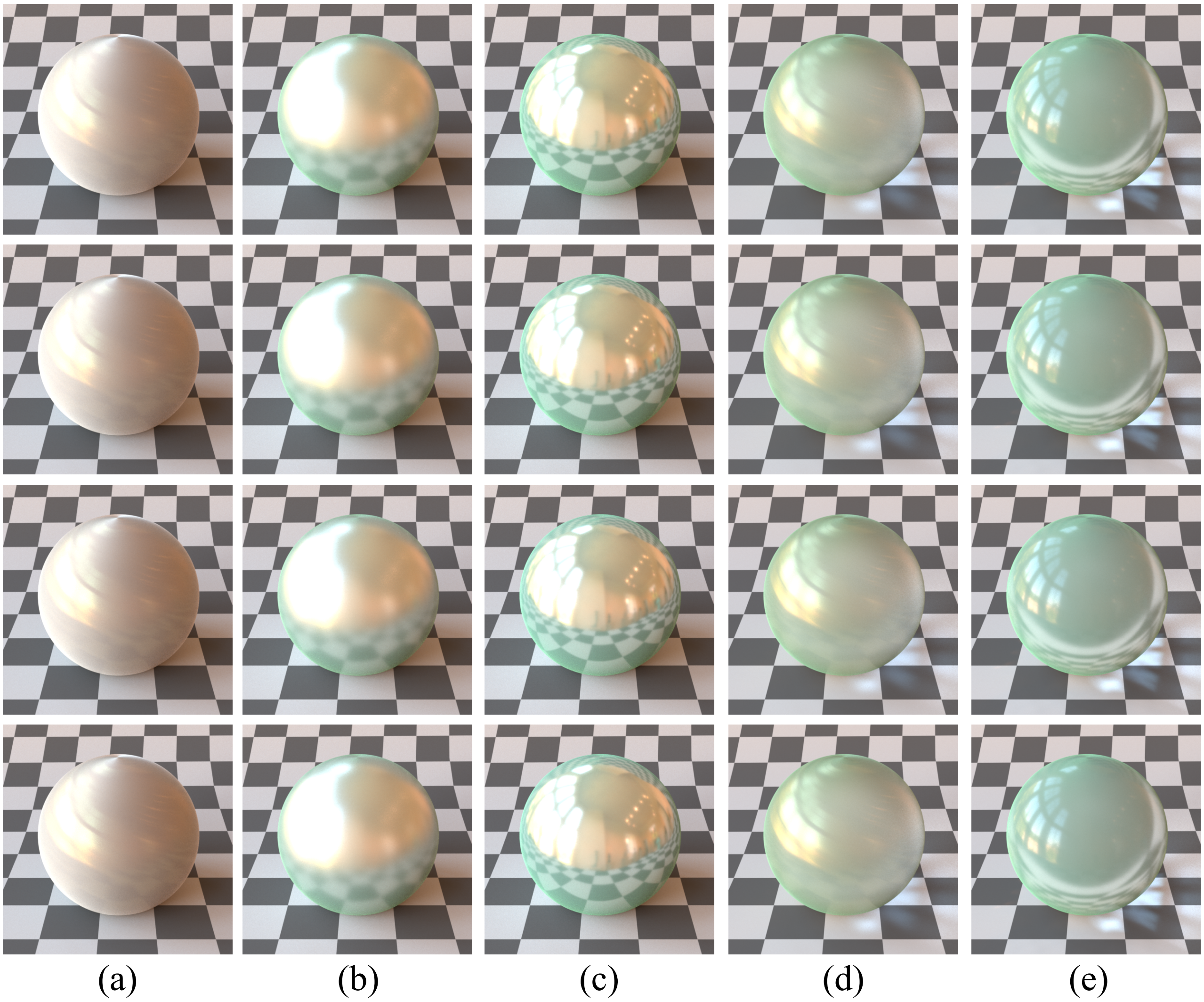
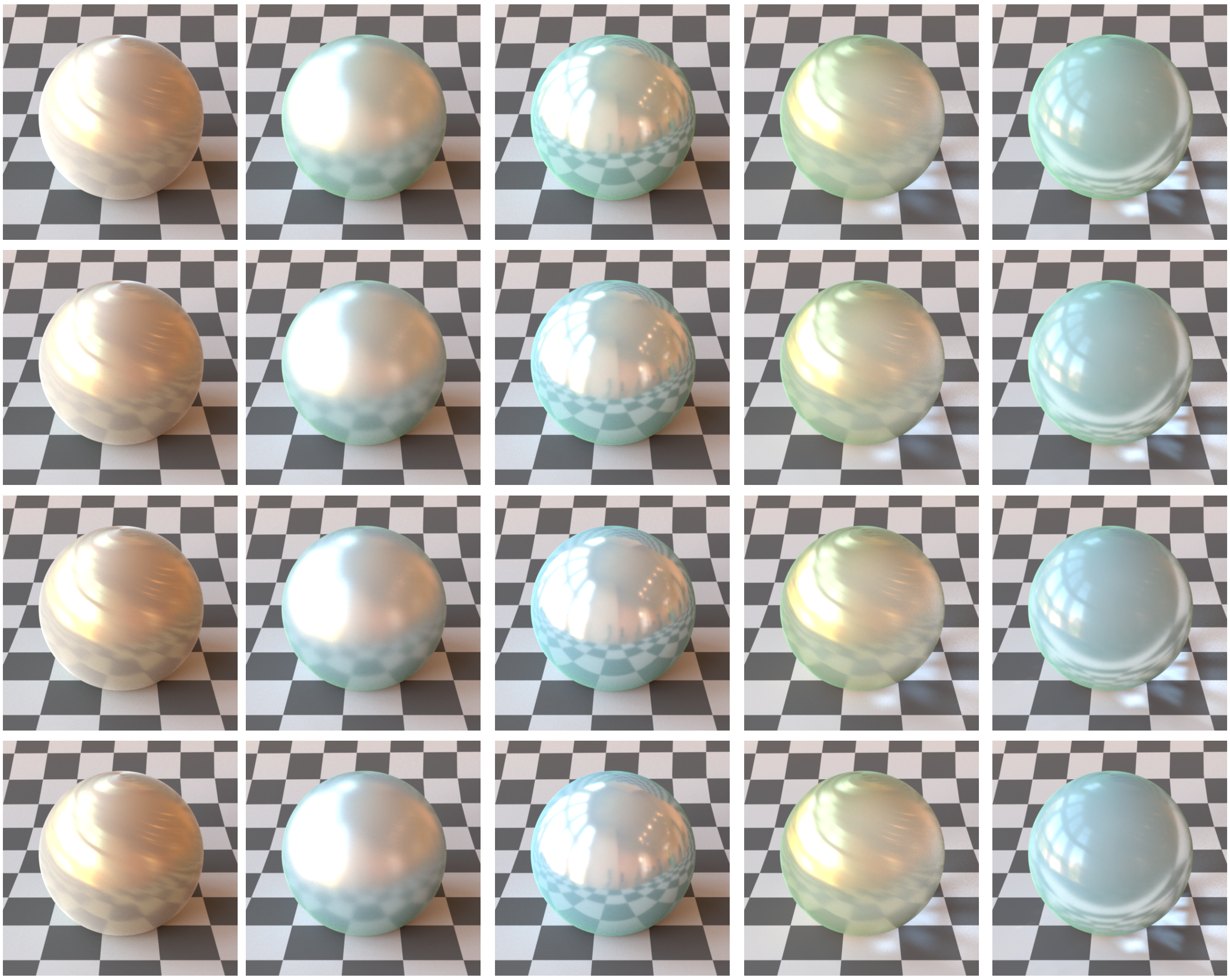


Figure 6: $\tau_{2,0} = 0.1$, varying on ratio of radius, from top to bottom : $\frac{r_2}{r_1} = 0.5, 1.0, 2.0, 4.0$. (a) gold micrograin (Au). (b) bluish plastic micrograin. (c) bluish diffuse micrograin. (d) gold micrograin (Au). (e) bluish plastic micrograin.



(a) (b) (c) (d) (e)

Figure 7: $\tau_{2,0} = 0.3$, varying on ratio of radius, from top to bottom : $\frac{r_2}{r_1} = 0.5, 1.0, 2.0, 4.0$. (a) gold micrograin (Au). (b) bluish plastic micrograin. (c) bluish diffuse micrograin. (d) gold micrograin (Au). (e) bluish plastic micrograin.

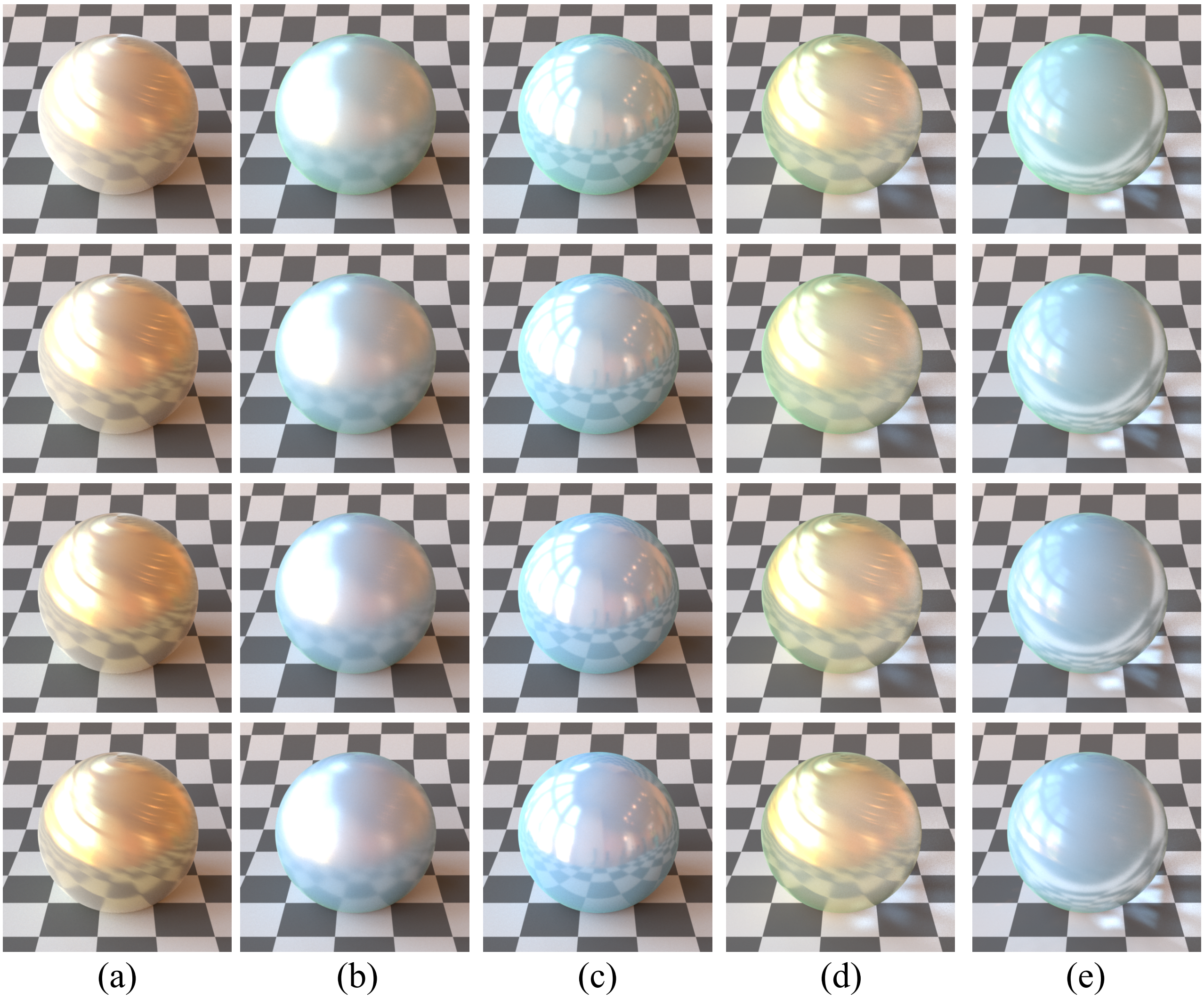


Figure 8: $\tau_{2,0} = 0.5$, varying on ratio of radius, from top to bottom : $\frac{r_2}{r_1} = 0.5, 1.0, 2.0, 4.0$. (a) gold micrograin (Au). (b) bluish plastic micrograin. (c) bluish diffuse micrograin. (d) gold micrograin (Au). (e) bluish plastic micrograin.

References

[LRPB24] Simon Lucas, Mickaël Ribardière, Romain Pacanowski, and Pascal Barla. A Fully-correlated Anisotropic Micrograin BSDF Model. *ACM Transactions on Graphics*, 43(4):111, July 2024.